BELL TELEPHONE QUARTERLY

VOL. XV JULY, 1936 NO. 3

TELEPHONY—CHILD OF ORGANIZED SCIENTIFIC RESEARCH

THE GROWING USE OF TELEPHONE "CONFERENCE SERVICE"

ALL AMERICA AT THE CONVENTIONS

THE BELL SYSTEM HISTORICAL MUSEUM

THE WORLD'S TELEPHONE STATISTICS: JANUARY 1, 1935

AMERICAN TELEPHONE & TELEGRAPH CO. • NEW YORK

BELL TELEPHONE QUARTERLY

A Medium of Suggestion and a Record of Progress

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VOL. XV NO. 3

PUBLISHED QUARTERLY FOR THE BELL SYSTEM BY THE AMERICAN TELEPHONE AND TELEGRAPH COMPANY. SUBSCRIPTION, $1.50 PER YEAR, IN UNITED STATES; SINGLE COPIES, 50 CENTS

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A General View of the Bell System Historical Museum. An Article Descriptive of the Museum Begins on Page 169.

Telephony—Child of Organized Scientific Research

Editor's Note:

Following is part of an address by Dr. Frank B. Jewett, Vice-President of The American Telephone and Telegraph Company and President of the Bell Telephone Laboratories, on the occasion of the presentation to him of the Franklin Medal by the Franklin Institute of Philadelphia, Pennsylvania, May 20th, 1936.

TELEPHONY or, in fact, any form of electrical communication, is truly a child of organized scientific research. It was born in a laboratory, it developed in a laboratory, and with the passing years it came more and more to derive its life blood from the creations of skilled scientists associated together coöperatively in great industrial research organizations. The fact that telephony in our modern world has come to be an extensive and vital part of our social and business structure tends sometimes to mask the dependence of the service on the research men. The huge sums of money invested in plant; the thousands of employees and the necessity of providing for their wages, their comfort, and their continued esprit de corps; the millions of daily contacts with customers; the vast and intricate relationships with government and a host of other things, all of vital importance, which each day have to be properly handled, create a superstructure which makes it easy to lose sight of the fact that, one and all, they are supported by the things which scientific men in laboratories have produced. Without these they would not exist. Further, so long as there is scientific knowledge, existing or acquirable, which can still be applied to better, to cheapen and extend existing modes of electrical communication or to create new ones, the whole superstructure is subject to realignment as a result of what these laboratory men do. Nor

can we stop the tide if we would, unless perchance we are prepared to commit social hara-kiri.

Limitation of time compels me to speak of but a single child of organized scientific research—telephony. What is telephony? Technically, it is all forms of electrical transmission of intelligence in which the ear is the ultimate detector and translator to the brain. Telegraphy, on the other hand, is electrical transmission of intelligence in such manner that the eye is the ultimate detector and translator. The instruments at the sending and receiving end of the circuit, the type of transmitting circuit, and all the intermediate apparatus may vary greatly without altering the fundamental concept of what constitutes telephony. All that we commonly think of as telephony, all radio broadcast, and all the sound portion of talking pictures is telephony by this definition. They are so treated in the research laboratory, since they require mere variant applications of a common knowledge and a common technique. Usually, solution of a specific problem in one sector solves or helps to solve problems in the other sectors.

Early Research Was Carried on Individually

A brief look backward will show clearly why telephony in all its parts is so completely and necessarily a child of organized scientific research. When Dr. Bell made his discovery, it was a scientific achievement involving the results of scientific discovery by others. It was not, however, organized research in our present-day sense. Nor was the work which followed in the years immediately succeeding the Bell invention. It was scientific and much of it was done under truly laboratory conditions, but in the main it was the work of scientists, engineers, experimenters and inventors working independently and more or less individually. This was a necessary condition and one always present in any new art. Everything had to be developed, facts of a simple character

had to be obtained, men had to be educated and, above all, underlying science had been explored only in surface spots.

For a few years there was much to do in developing more efficient and rugged transmitters and receivers, in evolving satisfactory signaling devices, and in working out switching arrangements for the expeditious connecting together of subscribers' lines. All of these things could be done by ingenious men familiar with and borrowing from the older telegraph art. In these years commercial telephony was wholly a community affair in which the transmission efficiency of simple line structures more than sufficed to provide for the inefficient terminal apparatus possibilities. Nor were there in these local systems many problems of interference either between telephone lines themselves or from other electric circuits. The lines were so few and so scattered that the simple expedient of physical separation usually sufficed when occasional trouble occurred. Further, there were no particular problems of space or cost in the central offices arising out of great congestion of line terminals.

Transmission and Switching Problems Soon Arose

Gradually, however, as instruments were improved in efficiency and reliability and as the use of this new means of distant communication increased, the need for and possibility of intercommunity service developed. With it arose the beginnings of those transmission problems and the problems of vast and intricate switching offices which have been our main concern for four decades.

At first the transmission problems were overcome by using larger wires, by a radical departure from the ground return circuit art of telegraphy to an all metallic circuit, and by a substitution of high conductivity hard-drawn copper wire for the iron or steel wire previously employed.

In the central offices, application of ingenuity in the reduc-

tion of part sizes and their more orderly arrangement, combined with clever circuit arrangements, sufficed for a time.

Soon, however, it became increasingly apparent that the obvious and easily followed roads of advancement were becoming fewer, narrower, and progressively more expensive. Likewise, the limitations of a purely individual type of trial and error attack on the numerous problems pressing for solution became manifest. Were the obvious economic and social advantages of a better, cheaper, and more universal development of telephony destined to be unduly hampered, if not blocked, by the difficulties immediately ahead?

Scientific Techniques and Trained Men Were Needed

Fortunately for telephony and for many other arts as well, the two decades from 1880 to 1900 were extremely prolific years in the fields of fundamental science research and in the rapid adaptation of educational curricula to the continually mounting store of new knowledge. A survey of telephony's problems in the light of what had happened in these two sectors convinced us that the problems were not insoluble. If, however, the solutions lay hidden in this newly acquired and rapidly growing fund of knowledge and in the techniques which had evolved it, it was equally apparent that they could only be had through the introduction of those same techniques and of men trained in them and with an understanding of the facts already unearthed.

Nor was the indicated course merely one simply of introducing men and techniques and proceeding along the essentially individualistic lines of the established development art. Most of the techniques, as well as most of the new knowledge, had been evolved by scattered individual effort in institutions of learning. Rarely, if at all, had the problems solved involved the necessity of simultaneous solution of a host of other problems in widely scattered fields; rarely was time, so vitally important in industry, the essence of the undertaking.

If, therefore, our salvation lay in the direction indicated, its attainment required a radical step forward in the use of science and scientific men. Moreover, it could not mean a complete break with all the values of the past. It must be a gradual introduction designed to refructify these old values, to indoctrinate the older order of men already successful in an earlier battle with a sense of the power inherent in the new tools, and so ultimately to reorganize the forward movement.

Was it possible to organize scientists for a mass attack on problems which might involve almost anything in the whole domain of the physical sciences? Could we analyze these problems in sufficient detail to permit of attacking the several parts successfully and on time? Could we synthesize our solutions in a form to make them commercially available? Would fundamental science continue to produce new knowledge in sufficient amount to justify the grand adventure? These and a hundred other similar questions confronted us and had to be answered affirmatively very largely on faith.

Three Decades of Research in Telephony

From the vantage point of our present knowledge, the questions seem trivial and the answers obvious. Thirty-five years ago it was otherwise. Then industrial research in any field, as we now know it, was sub-embryonic. We had little experience, and none at all in fields where the problems were so vast or the stakes of success or failure so great.

The story of the past three decades is far too long even to be touched on here. To a very large extent it is the story of the research department of the Bell System—the story of an organization which in that time grew from a handful of men to the present Bell Telephone Laboratories with its staff of approximately 4,500 men and women. What can be enumerated briefly are some of the more important direct results of organized scientific research in the field of telephony. They

are results which in the main could not have been obtained without it.

It has given us our vast urban telephone networks without unsightly pole line structures; it has made not two blades of grass grow where one grew before but literally scores of pairs of wires grow in cables in the same space where one grew before and has provided the means which make these present fragile filaments of copper more efficient conductors of speech than their much more robust ancestors. It has greatly improved the efficiency, uniformity, reliability and convenience of the instruments we use in our homes and offices. It has revolutionized the art of switching until our more recent central offices bear scant resemblance to those of even the World War period. It has enabled us to extend the range of commercial telephony from less than 1,000 miles until there are no land distances over which speech of adequate intensity and quality cannot be given. At the same time it has so altered, cheapened, and improved the transmission circuits that today we can afford to have enough of them of proper character to permit of completing practically every connection asked for while the calling party remains at the telephone.

The Fruits of Organized Endeavor

It has developed radio telephony so that ocean barriers to speech have been destroyed, and likewise communication made possible to and between ships, airplanes, and all moving vehicles. It has developed radio broadcast and initiated a great new industry in the realm of disseminating news, music, and entertainment. It has made possible the simultaneous transmission of a host of non-interfering messages over the simple circuit which before its advent carried but a single message and that but poorly. Finally, it has made possible the interconnection of all these things in any random fashion and in addition has given birth to a great new industry where sight and sound are joined for our edification and education.

Many of our present-day services of telephony could never have been done at all without the aid of organized scientific research. None of them could have been accomplished so completely and cheaply, had we had to depend on the fortuitous outcome of unorganized endeavor, no matter how scientific its elements. The history of each success in every major and minor achievement of telephony's organized research is generically the same—analysis, concentrated attack on the elementary problems, and synthesis to a final answer. Every branch of mathematics and of the physical sciences, as well as many of the biological sciences, has been examined and drawn on for aid; every new piece of knowledge which might be useful has been scrutinized; new knowledge in the fundamental sciences has been sought, to the end that a better, cheaper, and more nearly universal telephone service might be afforded the people of the United States. As an example of how far afield the quest has taken us, might be mentioned the fact that some years ago it became apparent that the whole structure of sound scientific research in many branches of telephony was based on having a much better quantitative knowledge of the exact mechanism of speech and hearing than then existed. We had then to adventure into the realms of physiology and psychology. We have obtained much of what we sought. Incidentally, we have, I think, enriched those fields.

What Does the Future Hold?

So much for the present. What of the future of organized scientific research in the field of telephony? Has the day of its zenith been reached? Have so many frontiers been crossed in the past thirty years that there are few that remain to be conquered? What is the future of this corps of highly trained scientists?

It is true in electrical communication, as it is in every other field, that a frontier once crossed can never again be a frontier. To those of us for whom the spanning of a continent or an

ocean with speech channels was once a challenge, our success closed the door forever to later generations. Today there is no barrier of distance or in the character of terminal station to telephony anywhere on the globe where man may be. The establishment of telephone channels is purely a matter of economics or of policy. But does this mean that in the future there is little place for an agency which for three decades has demonstrated its creative power in ever increasing measure? I think not, although it is obvious that the character of many of the objectives will be different from those of the past.

Organized Scientific Research Meets New Challenges

So long as efficiency and cost are factors limiting the free and untrammeled use of telephony, or so long as there is hazard to its operation through the development of interfering services, there will continue to be a challenge to organized scientific research. New increments of knowledge in many fields of science are potential tools in the field of a more efficient telephony. They may be knowledge as to new materials, new discoveries in mathematics, or new concepts of atomic structure; they cannot be neglected and a conquest of their possibilities will be as intriguing and profitable as any of the grosser adventures we older men have engaged in.

Even on the grosser side the future still presents the challenge of how best to render *all* the services of electrical communication. We have already gone far enough, as a result of our research work, to know that from a technical standpoint all of these services are part of a common science. We have still, however, to work out, partly in the field of science and engineering, partly in that of economics, and partly in that of government, the best way of handling the problem. The final answer will be determined very largely by what organized scientific research has to say on the subject.

We have built up a great organization of scientifically trained men competent to contribute new knowledge of a

fundamental character, to attack expeditiously and efficiently any problem which presents itself, and with a demonstrated capacity to produce results of a value far exceeding the expenditure of time, effort, and money required in their production.

Without venturing on the unsafe ground of speculation as to what further research in fundamental science may produce, we nevertheless know that there are still great vistas of possibility for scientific research in the fields of telephony and its sister services. It is still true here, as it has been for many years past, that each advance opens the way to yet other advances. For example, in the fields of multiple transmission of messages over relatively cheap and simple conductors, we know that it is theoretically possible to go vastly farther than we are yet prepared to venture. How far it will be commercially practical to go is something for the future to determine. In the last analysis, it is a problem for organized scientific research, to which finally the cold impersonal judgment of economics is applied.

Modern telephony, which is surely the child of organized scientific research, seems to me destined to continue in this status for many years to come.

FRANK B. JEWETT

The Growing Use of Telephone "Conference Service"

TELEPHONE conference service is a relatively new feature in the communications field offering interesting possibilities of substantial development. This service is appropriately named because it makes possible what the dictionary defines as an "appointed meeting for counsel, deliberation or discussion on some special matter." It is probably true that, inasmuch as two persons can "confer," every telephone conversation can be abstractly termed a "conference." But conference "service," as an offering of telephone companies, affords the opportunity for the meeting of several minds, instead of two only, "for deliberation or discussion," and its growing use reflects typical American impatience with obstacles and limitations, and the nation's typical imaginative adoption of instrumentalities that serve to overcome them.

There are four general types of conference usage. The first relates to telephone conferences entirely inter-office in character or with one or more participants outside the office, that are arranged for at a private switchboard on the premises of a telephone customer. The second comprises conferences between several individuals in a local area. The third refers to the use of toll and long distance circuits in order to interconnect several persons. The fourth includes instances where loudspeakers at one or several points have enabled groups instead of individuals to enjoy the advantages of the service.

Private Branch Exchange Conference Service

For telephone conferences of the first of these four categories, arrangements are made at the customer's private switchboard which permit the switchboard attendant to interconnect

several telephones. The usual arrangements contemplate the interconnection of as many as five telephones, two of which may be reached over outside lines; but special arrangements are possible whereby a larger number of telephones on the premises may be interconnected.

Such arrangements are obviously valuable to organizations with various departments located on different floors of a large building or in different buildings, since officials and department heads can "confer" without leaving their offices, with a consequent saving of time and energy. To call one or more to the "conference" who are not in the organization but who have business pending with it is the next step in utilizing these arrangements. There are routine usages in abundance to show how conference equipment on the premises "proves in." For example: The head of a large department store, faced with an urgent merchandising question, confers by telephone with buyers without requiring them to leave their departments. A chief engineer discusses production matters simultaneously with the mill superintendents concerned. Officials of a national bank use inter-office conference facilities for arriving quickly at a common understanding. The partners of a law firm talk together by telephone with a client, including a clerk or stenographer in the "conference" when necessary. A relief organization uses conference service so that several of its personnel may participate in discussions with officials at state headquarters. An electric power company has conference connections set up when conditions require immediate instructions or reports that involve foremen, load dispatchers, substation attendants or others, and crew foremen are enabled to interrupt the discussion and report to the conferees simultaneously. A chief engineer of a large construction project uses conference service every day to talk from some outside point simultaneously with several engineers at headquarters.

Local Exchange Conference Service

The examples just cited suggest the infinite variety of ways in which conference arrangements at a P.B.X. can be utilized to distribute information, exchange views, and reach decisions.

The same mutual benefits result from telephone conferences to individuals without private switchboards by utilizing the conference arrangements at the central office of the telephone company. Wherever the equipment has been installed, there are trained "conference operators" ready to interconnect up to six or more telephones. A local conference call may take the place of a series of individual calls, or may actually be a group meeting of several people. The potential value of this service as a time saver for busy people cannot even be estimated. There is obvious practical value in a communications practice that permits an automobile distributor to "meet by telephone" with five agents simultaneously, or the manager of a charity drive to hold nightly committee meetings of field executives without interruption of their canvassing, or a church official to hold bi-monthly meetings by telephone with his associates. It is reported that the by-laws of a school for crippled children have been revised to legalize transactions of trustees decided upon during their frequent telephone conferences. The following newspaper account in a western paper (of May 13, 1936) suggests how local conference service, here reported as a novelty, is destined to win approval everywhere because of its demonstrable worth:

Mosier Gets Busy Committee by the Ears for Conference

It's no longer a horse and buggy town we're living in. We have graduated in one fell swoop from the tank town class. City Manager Orval Mosier has introduced that ultra-metropolitan innovation, the "telephone conference."

At 1 p. m. or thereabouts on the epochal other day, Mosier summoned his secretary, Alice McElroy.

"We must have a meeting of the charities and solicitations

committee," he said. "The members are busy people. And we are busy people. Please arrange a telephone conference."

Rushing to her telephone, Mrs. McElroy called the conference operator, gave the names and phone numbers of the committee. Three minutes later the city manager's phone rang.

"Your conference is in session, sir," piped a sweet voice. It was a big moment at city hall.

"Call the roll, please," Mosier spoke into his phone, probably feeling a little silly because not a soul was with him in his office. From an adjoining office, Miss McElroy, her phone also hooked into the circuit, began:

"Granville Scanlan . . . Clyde Kemery . . . L. J. Bullis . . . M. L. Simpson . . . Mae Erbacher . . ."

* * *

After each name a different voice responded. The conference was on, with seven phones scattered over the city linked in the conference circuit.

"We'll now proceed with the regular order of business . . ." Mosier went on. And they did, approving four applications for permits to sell benefit tickets in the city.

Exactly 22 minutes later, a voice said, "I move we hang up," and the motion was unanimous. Six receiver clicks. Total cost of the conference was $1.75 at 75 cents for the first five minutes, 25 cents for each succeeding five minutes or fraction thereof.

The event went off without a hitch. Whenever someone wanted the floor, he broke in at the first pause, "L. J. Bullis speaking . . .

"Mr. Bullis has the circuit," Mosier would reply.

"It worked perfectly," Kemery commented Wednesday. "We got as much done as we would have in an hour and a half in Mr. Mosier's office."

Long Distance Telephone Conferences

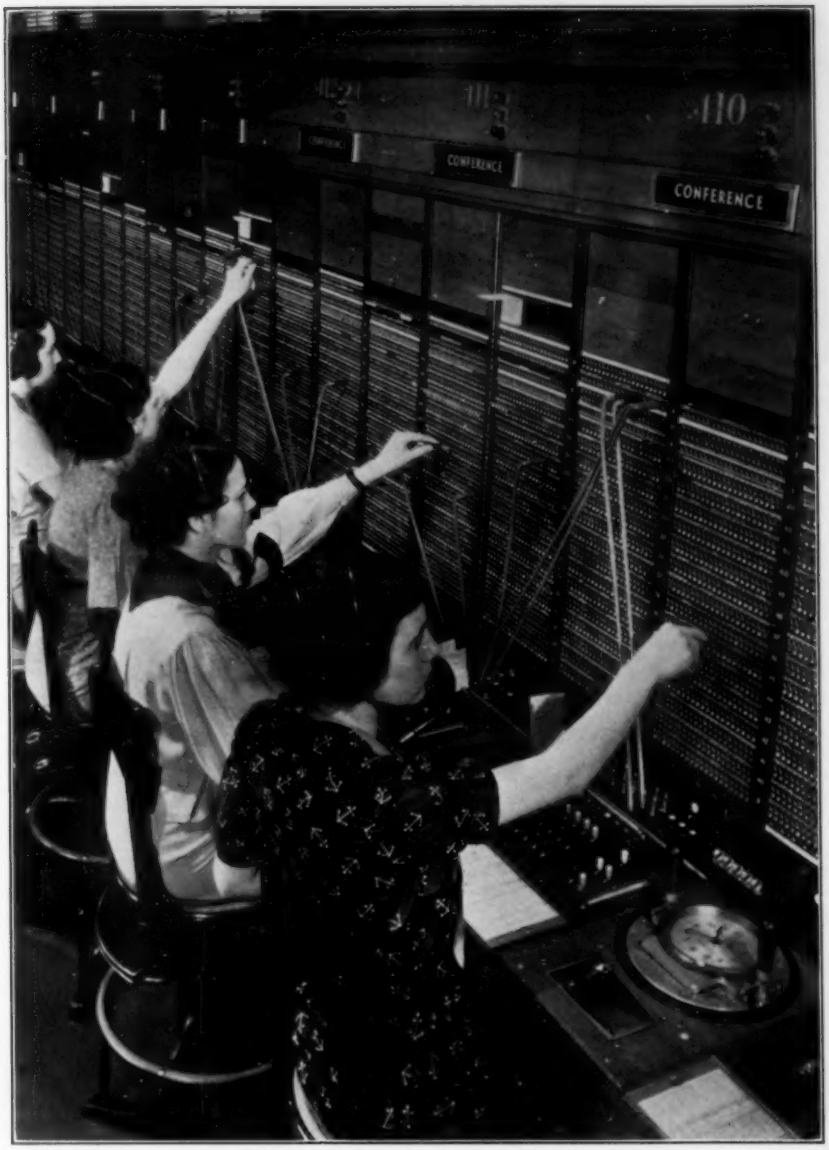
In an annual report issued a few years ago by the American Telephone & Telegraph Company, the statement was made that the year's most striking development was the growth of the "long distance habit."

This habit is now expressed statistically in the records showing a daily average of some two million and a half toll and long

distance telephone conversations in the United States. They indicate the importance of communications in a country of 3,000,000 square miles, populated by 127,000,000 people and with consequent far-flung inter-relations that are beyond computation. The vast activities relating to production, distribution, buying, selling, transportation, education, recreation and government, and the social relations of 31,000,000 families, are not only aided but stimulated by America's unrivaled telephone service, and long distance conferences by telephone are therefore as inevitable as individual conversations. With reduced night rates now available all day Sunday, a constantly growing "habit" seems certain of development.

There was a "sample" long distance conference a few months ago that must have stimulated the imagination of the radio listeners who heard it. The occasion was a broadcast commemorating the fiftieth anniversary of the incorporation of the American Telephone & Telegraph Company, and was marked by many features that showed how the modern telephone art has enlarged the scope of man's voice. One of these features was a conversation among five widely separated individuals.

These participants were Miss Grace Moore in Hollywood, California; Admiral Cary Grayson, President of the American Red Cross, in Washington, D. C.; "Dizzy" Dean, the well-known member of the "Cardinals" baseball club, in St. Louis, Missouri; Dr. Karl T. Compton, President of the Massachusetts Institute of Technology, in Boston; and Mr. Rufus Dawes, President of the Century of Progress Exposition, in Chicago. With special telephone circuits functioning, for broadcasting reasons, instead of the usual long distance circuits, the radio audience heard exactly what the five participants heard as they chatted with each other regarding the significance of the anniversary. But the practical significance of their talk as a program feature was the usefulness to the nation inherent



A Group of Operators Handling a Long Distance Telephone Conference at Conference Positions of the Long Distance Switchboard at 32 Sixth Avenue, New York City.

in long distance conference service as an agency of multi-point intercommunication. To speculate on this usefulness one has only to think, first, of the web of wires ready to function as channels of speech between any of more than 70,000 communities in the United States, and second, of the myriad situations arising in government, industry, agriculture or family life wherein a common understanding among several individuals is needed in the quickest possible time. The potential uses are as varied as the constantly changing needs and interests of the people. Actual uses already recorded indicate how mountain ranges, prairies, deserts, and even oceans seem non-existent as barriers to a meeting of minds when the conference service comes into play. The business stories are those of the improved efficiency in management because of conferences of a headquarters with its branches; of the stimulation given to selling campaigns because of multi-point discussion of competitive conditions; of important agreements involving many persons reached at a saving of precious hours. They are all exhibits in an American Exposition of Ways of Saving Time and Cutting Costs. They all illustrate how a long distance conference can serve many simultaneously in the same manner that a long distance conversation can serve two, as is shown in the following instances:

An attorney, who was handling a receivership settlement, was informed while out of town and just about to start on a vacation trip, that changed conditions in the case required his immediate presence at home. Rather than give up his vacation plans, he held a telephone conference with interested parties in three distant cities. In one five-minute conference, costing $18, a complete understanding was arrived at.

The division sales manager of a manufacturer and distributor of office machine equipment wanted to awaken enthusiasm for a sales campaign by talking personally with field salesmen who lived in the territories which they covered. The sales man-

ager held a telephone conference with the salesmen at their homes. He outlined to them the campaign plans and the details were discussed fully by all concerned. As a result, sales quotas were established, enthusiasm was inspired, and the manager had definite knowledge of the action that would be taken by each member of his sales force.

With a mid-western meat packing business there were frequent changes in price, and it was important to have the field representatives posted with as little delay as possible. It was also important to the sales manager, for his guidance, to have the opinion of the field as to changing local conditions. These matters had been handled by individual toll telephone calls, telegrams, and fast mail. Something better was wanted and so conferences by telephone are now held periodically by the district sales manager and attended by agents in different cities. Not only can headquarters now keep in close contact with the field and announce at first hand policy and price changes simultaneously to the agents, but the latter, brought together by telephone for discussion, understand changes better and make clearer their reactions to them. A considerable saving in time and money has been effected.

An interstate motor freight transportation company had been attempting to coördinate the movement of its trucks between points up to a hundred miles apart by individual toll calls, telegrams, and mail. This resulted in delays, errors, misunderstandings, and additional communications due to points raised by one branch affecting another. Now in a six minute meeting by telephone each day, costing $4.55, all branches and the home office are simultaneously informed of the number of trucks leaving each terminal, their destination, and the amount of freight each terminal will have to handle. Changes are discussed and rearrangements made "in the presence of all." This provides up-to-the-minute control of trucks and insures economical operation.

"Give to a Gracious Message a Host of Tongues"

What of the incidents in the use of long distance conference service where loving sentiment instead of business details have been the traffic of the wires? What point they give to Shakespeare's line, "Give to a gracious message a host of tongues"! Many hearts of young and old have indeed been gladdened

Family, 7000 Miles Apart, Exchange Phone Greetings

MERCED OFFICE STOCKTON RECORD, Dec. 26.—Members of the Stevenot clan exchanged Christmas greetings Christmas Eve over a span of 7000 miles bridged by radio waves and telephone lines connecting Merced, San Francisco and Manila.

It was 7:30 Christmas morning and mid-summer in the Philippines when Joe E. Stevenot, vice-president and general manager of the Pan A Telephone Company in Manila, called his California relatives at 3:30 yesterday afternoon.

The unprecedented private telephone hook-up was completed within a few minutes to eight phones in the three cities with more than 15 members of the Stevenot family participating in the 22-minute holiday conversation.

Besides Manila's warmth and California's cold, the seven brothers and sisters discussed gold mining prospects of the family in both California and the Philippines and the general return of business prosperity, according to Archie D. Stevenot of Merced, manager of Hotel Tioga.

On the wire at Merced were Mr. and Mrs. A. D. Stevenot, Mrs. Leonie Christensen and a niece, Miss Rosie Costa of Sonora. At San Francisco were Fred Stevenot, prominent banker and former director of the State Department of Natural Resources, with his wife; Cassie M. Stevenot and Mrs. N. Hildebrand of the bay region, and Mrs. Mae Gericke of Fallon, Marin county. Joe Stevenot was alone in Manila. Besides the brothers and sisters several of their children participated in the conversation. The Stevenots all were born at Angels Camp.

4 Brothers in Phone Reunion

Four brothers, one of whom is M. L. Fuller, United States weather observer here, held a long distance telephone "reunion" Christmas night, the connections covering a span of 1,500 miles.

Mr. Fuller received a telegram earlier yesterday from his younger brother, R. E. Fuller of Evanston, advising him to "be near a telephone about 9 o'clock." At that hour, the weatherman was called to the telephone and found himself in communication not only with his Evanston brother, but with two more, J. E. Fuller of Wilmington, Del., and A. C. Fuller of Cedar Falls, Iowa.

Not only the brothers, but their families as well, joined in the exchange of season's greetings and conversation during the "reunion." It was the first get-together in four years, Mr. Fuller said.

The "reunion" lasted for 10 minutes.

TWO NEWSPAPER CLIPPINGS REPORTING SOCIAL USE OF LONG DISTANCE TELEPHONE CONFERENCE SERVICE

because the far away voices of those absent from the family circle have come together in "conference." Perhaps if the telephone were an animate, sentient thing, it would consider this to be its pleasantest service. Frequently these telephone reunions have been reported in the press. Here is an account from the Peoria, Illinois, *Journal*, of December 26, 1934:

> Four brothers, one of whom is M. L. Fuller, United States weather observer here, held a long distance telephone "reunion" Christmas night, the connections covering a span of 1,500 miles.
>
> Mr. Fuller received a telegram earlier today from his younger brother, R. E. Fuller, of Evanston, advising him to "be near a

telephone about 9 o'clock." At that hour the weatherman was called to the telephone and found himself in conversation not only with his Evanston brother, but with two more, J. E. Fuller, of Wilmington, Del., and A. C. Fuller, of Cedar Falls, Iowa.

Not only the brothers, but their families as well, joined in the exchange of season's greetings and conversation during the reunion. It was the first get-together in four years, Mr. Fuller said. The reunion lasted for 10 minutes.

During the same Christmas season another reunion was thus reported in the Stockton, California, *Record:*

Members of the Stevenot clan exchanged Christmas greetings Christmas Eve over a span of 7,000 miles bridged by radio waves and telephone lines connecting Merced, San Francisco and Manila.

It was 7:30 Christmas morning and mid-summer in the Philippines when Joe E. Stevenot, vice president and general manager of the Pan A Telephone Company in Manila, called his California relatives at 3:30 yesterday.

The unprecedented private telephone hook-up was completed within a few minutes to eight telephones in the three cities, with more than 15 members of the Stevenot family participating in the 22-minute holiday conversation.

Besides Manila's warmth and California's cold, the seven brothers and sisters discussed gold mining prospects of the family in both California and the Philippines and the general return of business prosperity, according to Archie D. Stevenot of Merced, Manager of the Hotel Tioga.

Telephone Conferences with Loud Speakers

A recent letter to a telephone company manager reads in part as follows: "We were able to reach about 1200 men in our sales meetings throughout the country. The loudspeaker arrangement worked out very satisfactorily, and it is a splendid thing in getting an idea over to a sales organization in a quick way. Our organization, as a whole, was very enthusiastic and very much pleased with the service."

That seems to sum up the story. Groups of men in widely

scattered cities—distant executives with a message for all—conference service with loudspeakers added—and complete understanding, and unity of action resulting. For along the wires can flow personality to inspire confidence and awaken enthusiasm. There can be spiritual contact. There can be the question asked and the answer returned. Doubts and fears can be removed, management can speak directly and authoritatively. Matters can be settled not only conveniently and quickly but accurately. North, South, East and West can meet together at will. And voices from foreign lands can join the meeting, for, as was said during an historic 'round-the-world conversation by wire and radio on April 25, 1935, there are now "no earthly limits to human speech," by telephone.

It is interesting to note that even before "conference service" became a commercial offering in America, there was one historic international conference by telephone. On February 16, 1928, a thousand members of the A. I. E. E. were assembled in New York for their winter convention. Simultaneously the British Institution of Electrical Engineers was meeting in London. An overseas radio telephone channel, in operation only a year, was utilized to unite the two societies so that, in a joint session, they listened to addresses through loudspeakers and transacted business as though in a single auditorium.

As though in a single auditorium! At the time the experiment was recognized as an impressive demonstration of the telephone art's destiny in the service of mankind. Though not available as a service that can be furnished on a few minutes' notice, the incident serves today to give dramatic emphasis to the significance of the commercially available means whereby individuals or groups, though physically apart, may be united for discussion, debate, and decision. Prophecy need not pause when considering how mankind will ultimately adapt to its needs the service that eliminates the miles when a meeting of minds—a conference—is desirable or necessary at a

particular moment, either as a routine matter or in an emergency. The history of telephone development proves that telephone engineers have led rather than followed the demand for ever better and more useful means of transmitting intelligence, and this history proves also that supply has awakened demand. A time-saving instrumentality cannot fail to make its own market. It seems certain that "conference service" and human need will act and react upon each other just as previous telephone developments have done. It is already clear that a new telephone habit has been born, and there is no question as to its sturdiness and promise.

W. P. BANNING

All America at the Conventions

IN an article that appeared in 1879 in that instructive and entertaining journal *All The Year Round* conducted by Mr. Charles Dickens, a Dr. Lyon Playfair, "a scientific man as well as a politician," made an observation which must have startled not a few of the savants of his time.

"After witnessing some remarkable results obtained by the microphone, used in conjunction with the telephone," says *All The Year Round,* Dr. Playfair "expressed a belief that the speeches of great orators might, in the possible future, be heard by the whole population within five or six square miles."

Dr. Playfair himself would undoubtedly have been rather startled, had some one trumped his prediction with another, foreseeing the entire population of the next generation in the United States not only listening to the speeches of the great orators at a political convention, but—with all the ingenious technique of modern radio broadcasting, which is in itself a remarkable invention—getting a mental picture of the proceedings that was in some respects more complete than that of an actual spectator.

"We now take you to Cleveland," says the announcer in New York—or San Francisco, or New Orleans—and for all practical purposes we are there. From the "previews" of the arriving delegates to the closing scenes we follow the course of events. Chairman Snell bangs the gavel and it is heard in Maine, Florida, Washington, carried to every corner of the nation by a network of Bell System circuits to more than 200 stations of the National, Columbia and Mutual broadcasting chains as well as two score other stations operating independently.

We hear not only the speeches. An intricate system of some

seventy-five microphones, designed by National Broadcasting Company and used by all the broadcasting systems as well as the newsreel producers, enables us to follow every interesting and significant event in the hall. Now we are (electrically speaking) at the rostrum, now we are a few feet in front of the band. Perhaps a delegate is given the floor: the man at the microphone control panel operates a key cutting in a microphone a few feet from the delegate and we hear him as clearly as does the man next to him.

"The next order of business" is taken up with each state in its alphabetical order: We hear the Chairman of the Alabama delegation, "Alabama passes!"—then Arizona, "Arizona yields to Kansas!" Over the network wires comes the uproar that follows, brought to us by a "mike" suspended above the heads of the tumultuous delegates. Over the speaker's platform Columbia Broadcasting System has installed a "Demonstrometer" for registering the amount of noise. The indicator goes to the top and stays there.

The tumult and the shouting dies and a hundred broadcasting specialists move on. "We take you now to Philadelphia." Permanent Chairman Robinson makes his address, an enthusiastic delegate toots a battered cornet, the band plays "Everybody Loves My Baby." Another ingenious array of microphones devised by Columbia Broadcasting System picks up speech, music, noise—there are microphones on the rostrum, beside the band and the organ, and another mike suspended from the ceiling that catches background noise as those ribbons of fly-paper in the old-fashioned grocery store catch flies.

Perhaps there is a pause in the proceedings. Swimming in the sea of conversation that swirls around him, the delegate may wonder what it is all about. The little girl listening to the radio in Yakima could tell him. A "pause interpreter" is on the air to explain it to the audience of x million, listening to the stations of a great radio chain.

At Philadelphia a new method of broadcasting makes its first

News Will Flow Swiftly From Convention to World
Hundreds of reporters surrounding the long speaker's platform, extending 50 feet out in Public Hall. . . . Telegraph operators relaying the reporters' "
typewriters and tele
ices. Efficiency.
newspaper wire serv-
A corps of uniformed pages will notify delegates of phone calls.
BIG HOOK-UP READY FOR PHILADELPHIA
WIRE MAZE TO AID
Political Broadcast
Close
by Telephone
Delegates Put
On Air
WIRES READY FOR POLITICAL FLOOD
Long Distance Call
To Cong.
Latter Thinks Early Morning 'Phone Con
versation a Joke by Colleagues, But
Really Talks t
All America
at Convention
President Phones to Frie
Convention After

HEADLINES TELL THE STORY OF THE PART WHICH WIRES PLAY IN REPORTING THE NATIONAL POLITICAL CONVENTIONS.

appearance on the floor of a convention. Roving here and there in the auditorium, an NBC announcer carries with him a micro-wave transmitter. Buttonholing a prominent delegate, he interviews him on the spot, the colloquy being picked up by a receiver at the broadcasting control booth and sent thence to the network.

The curtain is rung down on the proceedings at Convention Hall and we move to Franklin Field. Seated comfortably in our living rooms we can almost feel the rain there and share, in a comfortably detached way, the uneasiness of the spectators as to whether it will turn into a steady downpour. We are glad to hear that it clears up, and settle down to listen to the preliminary speeches.

The handling of these speeches is an ingenious adaptation of "the microphone used in conjunction with the telephone" which had so impressed Dr. Playfair. From a group of eight booths in a building near Franklin Field, telephone wires lead to seventeen points—New York, Chicago, Portland, Ore., and elsewhere. Each terminates in an auditorium or an open air bowl, where local Democrats have gathered to hear the ceremonies.

At 9:45, prominent delegates to the convention enter these booths and address their respective constituents in the various auditoriums and open air bowls. As each finishes, a key is flipped and the local gathering is "cut in" on Franklin Field—and over the great wire network that serves the broadcasting companies they hear the ovation that precedes the President's address.

A striking illustration of the capabilities of the telephone forces on location at Philadelphia was furnished in connection with one of those unexpected developments which are usual on such occasions. At 12:02 P.M., one of the broadcasting companies informed the telephone company that an important interview was going to take place on the steps of the National

Committee's headquarters hotel at 2:15. They would like to put it on the air.

It was the noon hour, with half the force at lunch. They needed a line from the long distance office in the Bourse Building to the broadcasting company's control room some eleven blocks away, another to the headquarters hotel, and wires through the lobby to the scene of the interview.

The interview went on the air at 2:15.

Returning for a moment to our article in Mr. Dickens' Magazine, we find another interesting observation: "Such results," says the writer, referring to the experiments with microphone and telephone, "lead practical men to look forward to the day when one or other of these sensitive instruments will be available for reporting parliamentary speeches with a rapidity and accuracy never hitherto attained."

Practical men of the Press in the United States are already looking *back* to that momentous day, having covered two conventions by means of the telephone and its first cousin, the teletypewriter, with a rapidity and accuracy not only unattained hitherto, but quite undreamed of by the most fantastic prophets in 1879.

For if the convention demonstrated radio's new rôle in our political life, the part played by the Press was no less striking.

From the pencils and typewriters of 800 ladies and gentlemen of the Press a veritable gusher of words is set off that tumbles forth over telegraph wires, teletypewriter circuits and telephone lines to the roaring presses of great dailies hundreds, thousands of miles away.

It is a tremendous mobilization of men and machines for the rapid dissemination of news. We are back in Cleveland: Campaign Manager Hamilton announces that 51 of the Pennsylvania delegation are for Landon in an "interview" with the Press that reaches the proportions of a crowded town meeting, with three or four hundred reporters. The interview ends and the meeting melts with a rapidity not usually seen after an

opera performance. In fifteen minutes the story is on its way across 500 copy desks.

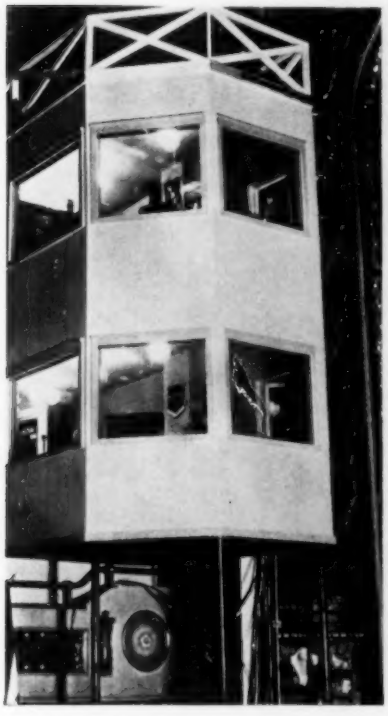
Or at Philadelphia, Senator Wagner is interviewed about the party's platform. Again a flood of copy is converted into electrical impulses, thence into linotype and so into headlines. Perhaps it is late for your morning paper in the East, it just makes the deadline in the Mid-West, while out on the Pacific Coast it is replaced by a later statement sent on by a corps of correspondents that grinds on twenty-four hours a day.

Let us look around at the facilities employed by these reporters, commentators and feature writers from every corner of the United States, from Europe, and even from Australia. Just below the rostrum are teletypewriters, morse keys and telephones—some connecting with the Press "workroom" in the basement that covers two city blocks, some with the city rooms of newspapers and press associations hundreds of miles away.

Down in the workroom more teletypewriters, morse keys and telephones, here and there among an array of typewriters, produce a clattering symphony that will cover the front pages of thousands of newspapers in a few hours; while over at campaign headquarters, in the lobbies of the big hotels, at the railroad stations—wherever the activities of a convention are visible or audible, a flying squadron of the Press is at work with pencil and typewriter—and then the telephone or the teletypewriter.

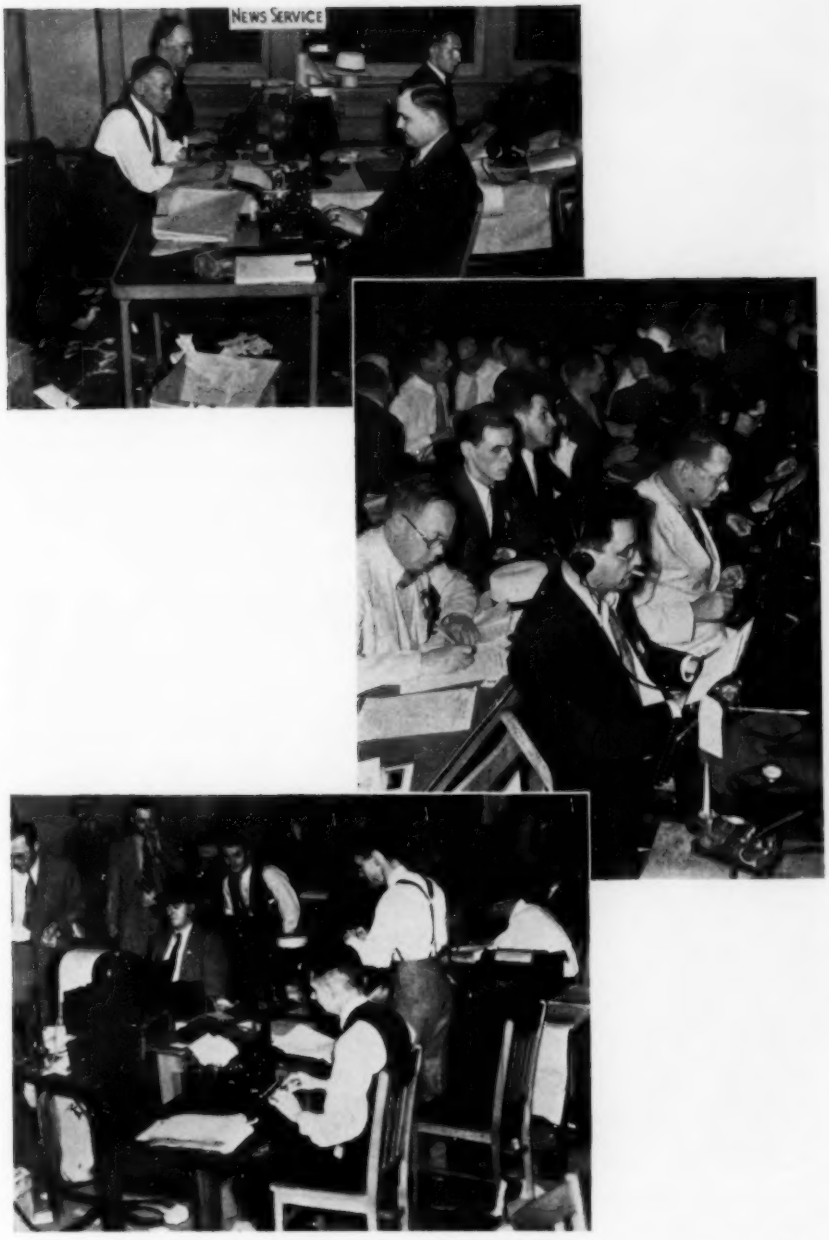
The Cleveland convention is galvanized by Governor Landon's telegram regarding the platform planks. The teletypewriters and morse keys at the Press platform send a "flash" pulsing over the wires to the copy desks in distant cities. The full text goes down to the workroom and the flash is followed by a complete story from the machines in the workroom. Or at Campaign headquarters in Philadelphia Chairman Farley issues an important statement. Another flash over the wires to distant cities, while the statement and accompanying story

Broadcasting Control Booths in the Convention Hall in Philadelphia.

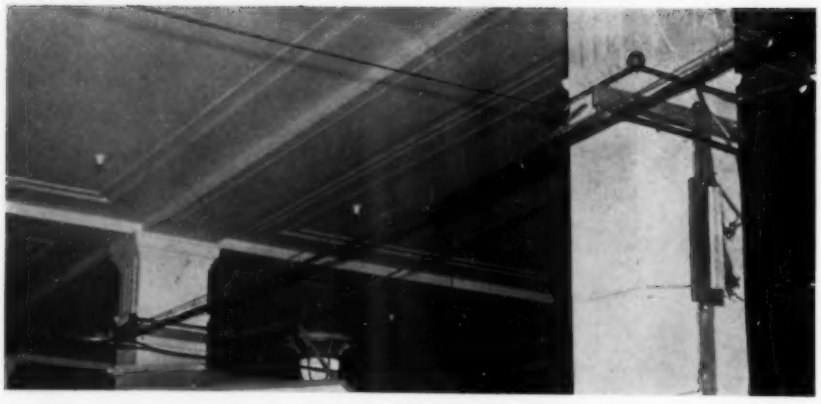


Broadcasting Control Booths in the Convention Hall in Cleveland.

INTERIORS OF BROADCASTING COMPANY CONTROL BOOTHS AT THE CONVENTIONS.



THE PRESS ASSOCIATIONS SENT MILLIONS OF WORDS OUT OVER THE WIRES FROM THEIR HEADQUARTERS IN THE CONVENTION CITIES.



A Special Installation of Telephone Wires, Entering the Convention Building as a 400-pair Cable, Carries Circuits to the Newspaper Workrooms.

In This Bell System Workshop in the Basement of the Convention Building, Attendants Are Checking Both Teletypewriter and Telegraph Circuits, While at the Test Panel in the Background All Bell System Circuits of Both Types Furnished to Carry the News of the Convention Can Be Tested.

follow as fast as the writer can tap it out. Or an important personage is met at the railroad station, and the reporter rushes to a pay station and gives the story to the workroom from scribbled notes on a fistful of copy paper.

Nor are all the broadcasting people and the reporters concentrated at Cleveland and Philadelphia. Governor Landon goes to the dentist, the President completes the rough draft of his acceptance speech. Both events are fully reported over the air and in the next revolution of the country's presses.

Of the total of more than 300,000 miles of Bell System circuits employed by the Press, it is impossible to say how much was directly involved in transmitting news from Cleveland and Philadelphia. Certainly a large part of it, for the main Eastern circuits of the Associated Press, the United Press Associations and International News Service, as well as Transradio Press Service, led right through press platforms and workrooms at both conventions.

Moreover, several large newspapers had special circuits to each city. All in all, there is no doubt but that practically the entire network furnished to press associations and newspapers was in regular daily use in connection with news of the conventions.

Not all of the 800 ladies and gentlemen of the Press at the Conventions were turning out words. Shadowing the reporter was the newsphotographer with his flashbulb and his "Smile please, Senator." For this is the day of the candid camera and the monster array of flashlights that illumine the vast auditorium to its Stygian depths with the brilliance of a million candles. The great reading public wants to see these political figures and convention scenes.

And a hundred photographers deploy about the city. At Cleveland, a tumultuous Kansas delegation parades with a covered wagon, or Miss Peggy and Grandfather Landon arrive. At Philadelphia Chairman Farley and Governor Lehman confer, or a loyal Democratic pilgrim arrives on horseback from

Dallas. They are all "light-brigaded" by the photographers.

Down in the workroom the Associated Press has a portable telephotograph set, connected to its telephotograph network. At New York, San Francisco and 23 other cities, a tiny beam of light flickers over a photographic film and in a matter of minutes pictures are in the hands of three-score newspapers.

Acme-NEA Service, International News Photos and Wide-World Photos also have portable telephotograph sets installed in the workrooms and connected to Bell System message circuits, from which they transmit to distant newspapers the lights and shadows of a crowded auditorium, a street pageant or a pretty face.

While broadcasting networks and press circuits carried the greater part of the geyser of words from the two gatherings, there were other Bell System channels that vibrated to a heavy flood. At Cleveland the Ohio Bell Telephone Company installed enough telephones to take care of a city of 10,000—in committee headquarters, in Press offices, in the Auditorium, wherever the tide of bustling citizenry gathered in pools.

In addition to a heavy traffic within the city that kept extra operators at the Company's exchanges throughout the twenty-four hours, the convention set a figure on long distance usage that was some 30 per cent above normal, and 300 calls above the peak set by the floods last March. And its ebb and flow was quite different from normal traffic, reaching its peaks at the most surprising hours: One "at about the sixth hour, when beasts most graze, birds best peck and men sit down to that nourishment which is called supper"—and usually show something approaching apathy for the telephone. And another peak of even more impressive proportions in the witching hours between midnight and 7 A.M.

A not inconsiderable part of this traffic at Cleveland originated with a National Committee whose new chairman had already shown a highly developed technique with the telephone

in a two-weeks long distance campaign in which he talked with the chairmen of the state delegations almost daily.

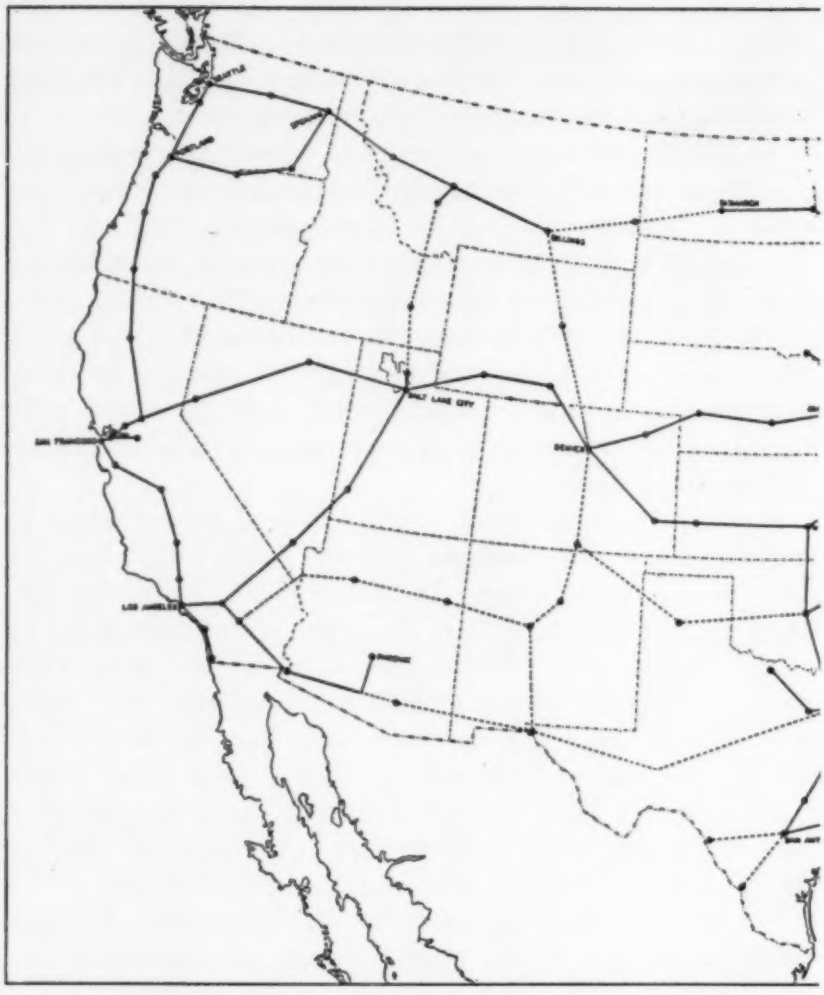
There were others outside the city who helped swell the traffic. Arrived at his hotel, ex-President Hoover found two telephones, with long distance calls, awaiting him. Ten more backed up behind them before the pressure eased.

At Philadelphia, another telephone system large enough for a thriving young city was installed by the Bell Telephone Company of Pennsylvania. As in Cleveland, the local and long distance staffs were augmented to take care of a heavy increase in traffic. Down at the Bourse Building in Philadelphia, where the long distance switchboards are, the volume of outgoing calls ranged from 25 to 30 per cent above normal, and it is estimated that the figure on incoming calls was about the same. The crest was just under the great tidal wave of calls precipitated by the March floods.

In addition to the more familiar uses of the telephone by committeemen and delegates, it found employment that was both interesting and novel. In Philadelphia's Convention Hall, the band is in the rear gallery, the organ out of sight under the stage. Under such circumstances, it is easy to foresee something of a musical impasse if the organist launches into "Moon over Miami" at about the same time that the band leader decides the mood of the delegates calls for a Sousa march. The problem is solved by four telephones, one at the organ console, one beside the band leader, one at the rostrum—and one at the camera platform, for the benefit of the newsreels.

Another important accessory of the cameraman, the eight great searchlights in the gallery, is likewise controlled by a telephone party line—one at each light and one at the camera platform.

The use of the telephone at political conventions has ample and fairly venerable precedent. During the Republican convention in 1896, according to a newspaper dispatch at the time, William McKinley, at his home in Canton, O., was in touch by



BELL SYSTEM ROUTES NOW USED FOR PROGRAM TRANSMISSION, OVER WHICH LINES DENOTE ROUTES OF PERMANENT PROGRAM CIRCUITS;

BROADCASTS OF THE CONVENTION PROGRAMS WERE TRANSMITTED. SOLID DOTTED LINES DENOTE TEMPORARY OR EMERGENCY ROUTES.

telephone with the convention hall at St. Louis. And in 1936 Governor Landon is in touch with every development at Cleveland over a private line between his office in Topeka and campaign headquarters established by Manager Hamilton; while in Washington, the President turns to the telephone to express to Judge John E. Mack his admiration for the latter's nominating speech.

Another Bell System service made its appearance at the conventions. This was "TWX," or teletypewriter exchange service, in which teletypewriters are interconnected just as two telephones are, through a teletypewriter exchange. At Cleveland and Philadelphia, a number of additional stations were installed for broadcasting companies, newspapers and at campaign committee headquarters. One of the broadcasting companies employed "TWX" to good effect for readjustment of schedules to meet unexpected developments at the convention.

With the development of the electrical transmission of speech and signal, we have come a long way toward the solution of the problem of that "satiable curtiosity" which has been at once the cause of our most acute headaches and our grandest thrills. The Press, the radio and the telephone, all fed from these great wire networks, have enabled us all to enjoy, in our own homes, that tonic pleasure which drew those great multitudes of Athenians to the Areopagus, where, according to St. Paul, "all the Athenians and strangers which were there, spent their time in nothing else but either to tell or to hear some new thing."

We have our newspaper at the breakfast table, and again after the last big-league game of the day; we have our radio set in the living room. We have telephones in easily accessible parts of the house. We have our own Areopagus.

GEORGE G. BREED

The Bell System Historical Museum

LISTED in the "Handbook of American Museums," published by the American Association of Museums, is

THE BELL SYSTEM HISTORICAL MUSEUM
463 West Street, New York, N. Y.
Established: 1913
Control: American Telephone and Telegraph Company
Field: History of electrical communication art
Collections and exhibits: Instruments, models, and photograhs illustrating important steps in the development of the electrical communication art beginning with the earliest and extending through the years to the latest developments now in service.
Quarters: Room in executive area in Bell Telephone Laboratories. Floor space: approximately 3,000 square feet for exhibits.
Admission: Free, during business hours by appointment.

The history of this historical museum started in the autumn of 1912, when John J. Carty, then Chief Engineer of the American Telephone and Telegraph Company, initiated the first step to preserve in one place the relics of the telephone art. They were to be kept in the then Engineering Department of the Western Electric Company at 463 West Street, New York, which in 1925 became the Bell Telephone Laboratories. Early in 1913 Wilton L. Richards was appointed Curator and authorized to collect and classify the material to be obtained. This was a fortunate move, as Mr. Richards had been identified with the laboratory work of the System since 1878, when the Blake Carbon Transmitter was first brought out, and he was familiar with the developments practically from the beginning.

A canvass was made by letter of all the operating companies in the United States and, through the Western Electric affiliations, in Europe and even as far as Australia, for gifts or loans of apparatus, or photographs of old telephone equipment. At

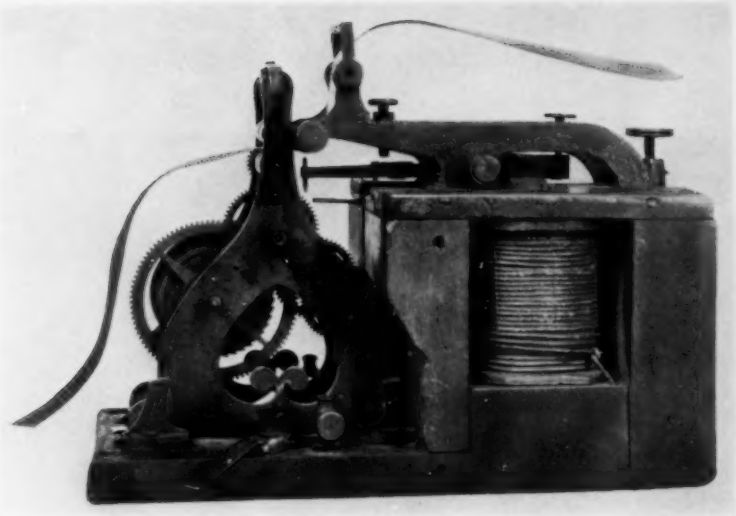
the Telephone Pioneers' Convention that year, a personal appeal was made to its delegates. From the beginning the policy has been to receive gifts or loans and not to purchase any exhibits, and to add the name of the donor or lender to the exhibit card.

The responses from all sources were generous. The larger groups of material came from the collection of early instruments and models of the American Telephone and Telegraph Company in Boston, and from the Western Electric Company Sales Department in New York, where they maintained an exhibit of modern electrical appliances and, as a sideline, some historical telephone apparatus. At first, the museum material was housed in a small room on the seventh floor of the West Street building, then moved to two successively larger rooms on the twelfth floor and finally to the present location on the eleventh floor.

The papers and documents that were collected during the early years were turned over to the American Telephone Historical Collection, organized in 1922 and later named The American Telephone Historical Library, at the American Telephone and Telegraph Company Headquarters, 195 Broadway, New York. This Historical Library collects and preserves the important documents, pictures, and other historical and biographical material relative to the Bell System. This collection emphasizes the economics and personalities of telephony, while the Museum emphasizes the technical advances—the two supplementing each other. William Chauncy Langdon, Historical Librarian, has described the Historical Library in the January, 1924, and April, 1925, issues of the QUARTERLY.

On the walls of the entrance aisle to the Museum are two groups of photographs—one of pioneers in the development of the telephone, and the other of the present directorate and executive staff of the Bell Telephone Laboratories.

Today there are nearly 2,000 separate items on exhibit in the thirteen double cases, two pylons, and mounted on the

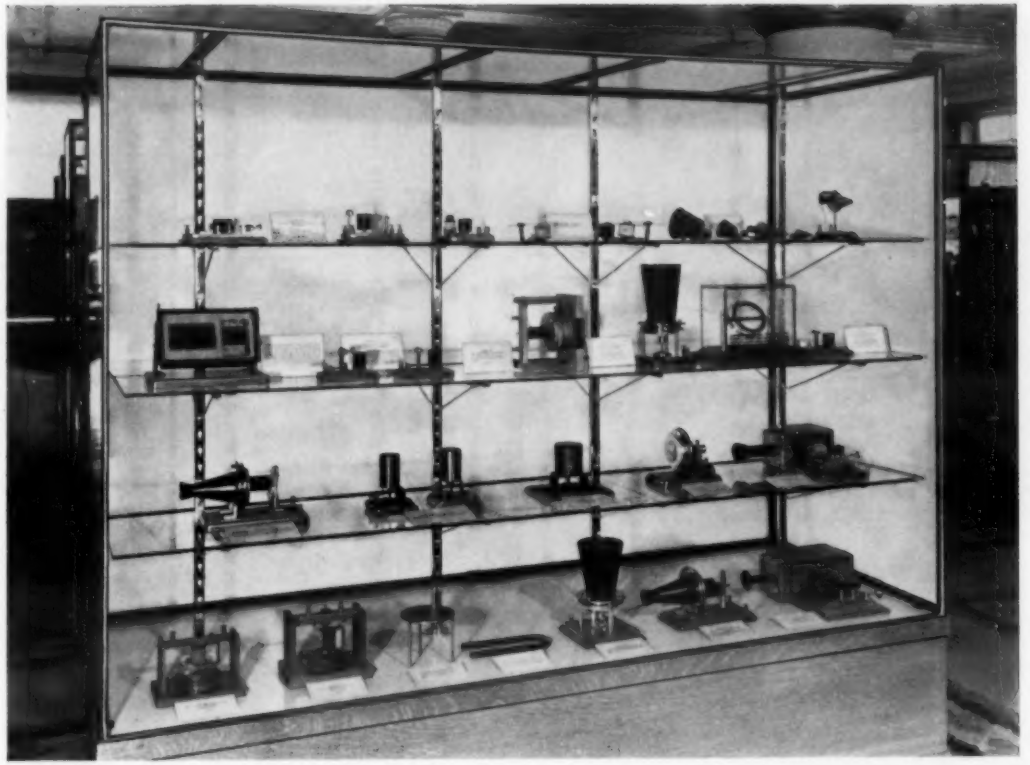


A Telegraph Receiver Made by Samuel F. B. Morse in 1843.

FIGURE 1

A Complete Elisha Gray Printing Telegraph Machine, in Use in 1872.

FIGURE 2



Exhibits of Developments During the Years 1874–77, Prior to the Commercial Telephone.

FIGURE 3

walls. A general view of the Museum is shown in the frontispiece.

The Telegraph Precedes the Telephone

The earliest exhibit chronologically is a telegraph receiver (Figure 1) made by Samuel F. B. Morse in 1843, the year before the first telegraph line was opened between Baltimore and Washington, and then follows a group of early telegraph repeaters, sounders, relays and keys in the 1850–1860 period. One historic relic in this group is a telegraph key from Washington, D. C., on which acknowledgment was made of the message from General Grant at Appomattox to Lincoln at Washington that General Lee had surrendered and the Civil War was ended. Pieces of Cyrus W. Field's first, second, and third Atlantic telegraph cables, dating from 1858 to 1866, are also on exhibit. In addition, there is a complete Elisha Gray printing telegraph machine which was used in 1872 (Figure 2). The telegraph was in full swing prior to the invention of the telephone, and it was during some tests on a harmonic telegraph system being developed by Alexander Graham Bell that the principle of the undulatory vibrating current as the basis for speech transmission was verified. So, there is some justification for the display of early telegraph devices before the advent of the telephone.

Early Experimental Models

Possibly the easiest way to describe what the Museum contains in the form of exhibits and their relations to the developments of the communication art is to make an inspection of the Museum, in the company of its Curator. We begin with the case devoted to the experimental work of Bell and Thomas A. Watson, his assistant, before the telephone became a commercial instrument (Figure 3).

It illustrates a fascinating story—that of the laboratory work

on the telephone prior to its commercial application. Here we may get a picture of the orderly developments from the mental conception to a practical instrument, and also opportunity to record briefly the times, places, and instruments used in the "first" successful tests with the telephone.

In this case the important stages are shown on the second and third shelves from the top, beginning at the left. We first see two original smoked glass records made by Professor Bell and Dr. Clarence John Blake in 1874. They represent sound waves and were made with apparatus that used parts of a human ear as a means of moving the recording stylus. It was these experiments that showed Bell that a diaphragm could, by its motion, reproduce all the elements of a sound wave and led to his conception of the electric speaking telephone, while visiting his parents in Brantford, Canada, during August of that year.

Next are facsimiles of Bell's vibrating reeds for his harmonic telegraph, one a transmitter with its contact for making and breaking the current, and the other a receiver. It was on that memorable day, June 2, 1875, when Bell and Watson were testing a number of these transmitters having various sizes of reeds for the different frequencies, connected by a single wire to a corresponding set of vibrating reed receivers, that the first sounds were transmitted electrically. The adjusting screw on one of the transmitters happened to be screwed down too far. Watson snapped the reed to open the circuit, but the circuit remained closed through the screw while the reed by its vibration over the pole of its electro-magnet was generating that conception of Bell—a current of electricity that varied in intensity precisely as the air was varying in its density within hearing distance of that spring. That undulating current had passed through the connecting wire to the distant receiver which Bell had to his ear and caused its vibrating reed to reproduce faintly the sound of the vibrating spring of the transmitter.

The First Telephone

Following these exhibits, we see the replica of the telephone made and tested the next day, through which voice sounds were first electrically transmitted—the first telephone. This transmitter has the same electrical structure as the harmonic telegraph transmitter except that the vibrating reed is hinged at the magnet and the free end under the pole-piece of the electromagnet is secured to a large gold beater's skin membrane stretched over the mouthpiece. The varying intensities of the speech sounds caused the skin diaphragm and the attached reed to vibrate and the vibrations of the reed generated a current varying in proportion to the sound intensities. The receiver at the other end of the line was a harmonic vibrating reed receiver the same as used by Bell the day before.

These two tests, June 2 and June 3, 1875, were conducted in the building at 109 Court Street, Boston, Mass., occupied by Charles Williams, Jr., Manufacturer of Electrical Supplies. Watson, who was employed by Williams, had been assigned to make Bell's experimental apparatus and to assist him in his work. The June 2 test with the harmonic telegraph instruments was made in the two adjacent front rooms on the fifth or attic floor. For the June 3 tests, these rooms were so close that the voice carried through the air and would interfere with the tests over the wire. Watson, therefore, ran a wire from one of these rooms down two flights of stairs to the third floor of Williams's shop, ending it near his own work bench in the rear. This first telephone, often referred to as the "gallows frame" telephone, was connected to the line terminating near Watson's bench and the vibrating reed receiver to the other end in the attic room. Voice sounds were plainly heard over this first telephone line but they were not sufficiently distinct to be intelligible. Bell's conception in 1874 of the speaking telephone was thus verified on the instrument tested on June 3, 1875.

Several modifications of the gallows frame telephone were made immediately afterwards. Two of such are shown in the left corner of the bottom shelf of the case.

The Liquid Transmitter

The next important step is the "liquid" transmitter of March 10, 1876, seen immediately to the right of the gallows frame telephone. This is a replica of the telephone through which the first articulate words were transmitted and understood at a distance over a wire. Bell applied to this transmitter the principle of an electric spark arrester he had been developing for some time previous for use with his multiple telegraph. In this he regulated the resistance between two wires by dipping their ends in a vessel of water, varying the resistance by changing the depth to which the wires were submerged. In the telephone, a wire rod is attached to the stretched membrane and projects downward just dipping into the cup of acidulated water (dilute sulphuric acid). With the vibrations of the diaphragm the wire rose and fell in the liquid, producing changes in the resistance of the circuit through the rod and liquid. This caused corresponding changes in the electric current passing over the wire through the vibrating reed receiver with the resulting reproduction of the original sounds.

To the right of the liquid transmitter is the original wire over which the first complete and intelligible sentence was transmitted and at its right is a replica of the vibrating reed receiver.

This first sentence, "Mr. Watson, come here, I want you," was transmitted on the evening of March 10, 1876, between two rooms at 5 Exeter Place, Boston. Bell had moved his laboratory from Williams's attic at 109 Court Street, in January, 1876, for more privacy and had rented two rooms, again in an attic, at the Exeter Street boarding house. The room facing Exeter Street was used as his bedroom. The other, at the rear looking out on the back of the buildings on Hayward Place, was

fitted as his laboratory. The test wire ran between these two rooms. On this night, the liquid transmitter was in the laboratory and the vibrating reed receiver was connected to the wire in the bedroom, in which Watson was stationed for the test. Bell accidently overturned the acid of a battery, spilling some on his clothes. His call to Watson, that first sentence, was an appeal for assistance. Watson could not answer, as he had only the vibrating reed receiver, so he rushed down the hall and into Bell's laboratory exclaiming, "Mr. Bell, I heard every word you said,—distinctly."

The original wire in its own glass case has other historic associations. When the transcontinental telephone service was formally opened on January 25, 1915, in the ceremonies held in New York and San Francisco this wire was placed in the circuit at New York, where a replica of Bell's gallows frame telephone was used as a transmitter by Mr. Bell, who repeated that famous first sentence to Mr. Watson, who was at the other end of the line in San Francisco. On January 23, 1931, Mrs. May Bell Grosvenor, a daughter of Mr. Bell, spoke through another replica with this original wire in the circuit addressing in a clear voice a gathering of more than 4,000 people at a meeting of the National Geographic Society in Washington, D. C.

Apparatus Used in Demonstrations

The instruments at the left of the third shelf in the case are a single pole membrane transmitter and two iron box receivers, replicas of those demonstrated at the Philadelphia Centennial Exposition in 1876. During the demonstration before the judges of the Exposition and guests on Sunday afternoon, June 25, 1876, Mr. Bell spoke through the transmitter at a distance in the hall over a line connected to an iron box receiver near the table of miscellaneous telephonic and telegraphic apparatus exhibited by Bell. The first person to listen with the receiver was Dom Pedro, Emperor of Brazil, who exclaimed, "My God —it talks." Among those who witnessed the demonstration

that day were Sir William Thomson, Joseph Henry, Elisha Gray, and other men of science.

This transmitter was an evolution of the gallows frame type, with an armature composed of a small disc of thin sheet iron or steel glued to the center of the membrane diaphragm. While the liquid transmitter was the prototype of all the forms of variable resistance transmitters which were developed later, it would not prove a commercial device, and Bell devoted his energies to perfecting an instrument with a vibrating iron or steel unit in a magnetic field.

The iron box receiver was the ultimate of the vibrating reed receiver, a ring of iron with the adjustable center core and helix and a round diaphragm of iron or steel as the vibrating member. And we still use the circular iron diaphragm in our present day receivers.

The next exhibit to the right is an oversize iron box receiver made by Bell to be used in transmitting speech from Boston to Philadelphia. There is no record that this test was ever carried out, but this instrument with its high resistance winding on the helix was tested successfully over an artificial line having a resistance approximating 350 miles of telegraph line. Bell's reasoning that the resistance of the coils of wire in the transmitting and receiving instruments should be higher for the higher resistances of the longer lines was verified in these tests.

We can touch upon only the high spots of these strenuous days. The next exhibit is a replica of one of two similar telephones used in the first "long-distance" two-way or reciprocal telephone conversation. The small iron disc on the centennial transmitter was changed to a large thinner iron disc almost the size of the membrane itself. The mouthpiece was omitted and this structure operated equally well as a receiver and as a transmitter.

This conversation was held on the evening of October 9, 1876, using a telegraph line of the Walworth Manufacturing Company between their office in Boston and their factory in

Cambridgeport, a distance of about two miles. The test was satisfactory and for the first time reciprocal conversation was carried on successfully over the same wire by persons using the same kind of instrument both as transmitter and as receiver.

In passing it should be recalled that the first long-distance telephonic transmission occurred in Canada during August, 1876, between Paris and Brantford, a distance of eight miles. At Paris, an iron box receiver was connected to the line and at Brantford a membrane transmitter. The transmission was in one direction only. The return had to be made by telegraph.

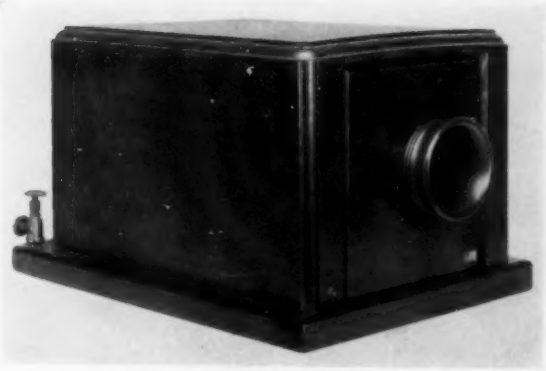
The Permanent Magnet Telephone

The next and final exhibit illustrating a major change in development is shown at the right end of the third shelf, the telephone with the permanent magnet replacing the previous electro-magnetic structures and a complete iron diaphragm in place of the disc of iron attached to a membrane. The diaphragm was secured to the front of the box cover into which was inserted a mouthpiece to concentrate the sound vibrations to the center of the diaphragm, and there was a screw adjustment for bringing the magnet, coil winding and pole-piece to the proper space behind the diaphragm. This combination was developed some time during December, 1876, prior to Bell's departure for his father's home in Brantford, Canada, on December 22, 1876. It was disclosed in Bell's second telephone patent, No. 186,787, application filed January 15, 1877, granted January 30, 1878. This design gave such superior results that all previous forms of membrane receivers and transmitters were then discarded. It operated equally well as a transmitter and as a receiver, and this type, known as the box telephone, became the first form of commercial telephone in 1877.

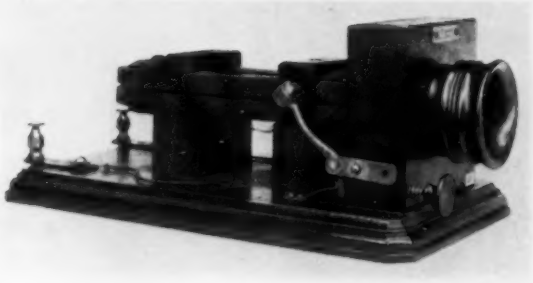
Other Experimental Models

Before passing to the commercial instruments, let us glance briefly at the other experimental models in this case. On the top shelf we see at the left three replicas of Bell's efforts in multiple or harmonic telegraphy, a current interrupter, a tuned reed receiver and a harmonic telegraph receiver. To the right are shown a group of models of vibrating reeds referred to as "Figure 5," and several transmitter and receiver units referred to as "Figure 7," in Bell's first telephone patent, No. 174,465, application filed February 14, 1876, granted March 7, 1876. These models were made some time later to prove to different courts during litigation that Bell's patent specifications disclosed structures that would operate successfully. The models of "Figure 7" have the same structure as the original gallows frame telephone; those with the large openings tapering down to the membranes to concentrate the sound vibrations on the diaphragms were used for transmitters, and those with the cones to concentrate the received vibrations to the small openings held to the ear were used for receivers. All of Bell's transmitters and receivers, with the exception of the liquid transmitter and the vibrating reed receiver, could be used for both transmitting and receiving, although the best results were obtained when used as described above.

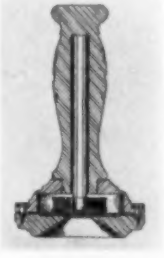
On the bottom shelf we see, beginning at the left, two modifications of Bell's gallows frame telephones; a large iron diaphragm supported on three legs, used in June, 1876, for both transmitting and receiving with electro-magnets of different types; a large permanent magnet exhibited at the Philadelphia Centennial for illustrating the production of magneto-electric currents corresponding to sonorous vibrations; a replica of the liquid transmitter of March 10, 1876, also shown at the Centennial; a double pole membrane transmitter with two electromagnets similar to the single pole Centennial transmitter; and lastly, a modification of the box telephone, on the shelf im-



Box Telephone, the First Commercial Telephone: 1877.



Box Telephone with Addition of "Watson's Thumper"; Cover Removed: 1877.



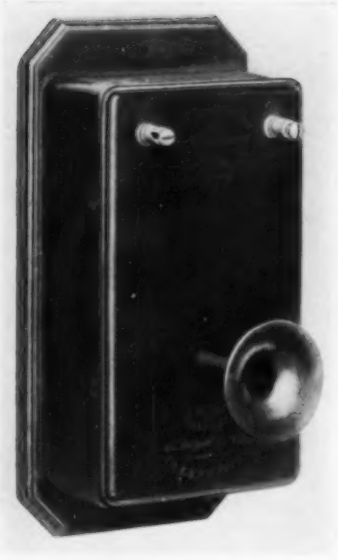
Cross-section of "Butter Stamp" Hand Telephone: 1877.

Large Rubber Hand Telephone: 1877.

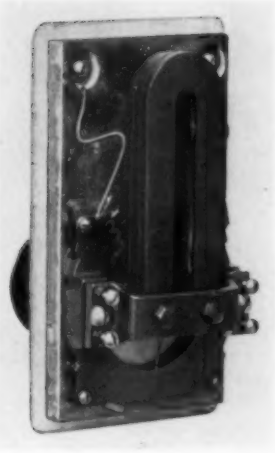
Hand Receiver: 1902.

Hand Receiver: 1912.

FIGURE 4



Box Telephone for Wall Mounting: 1877.



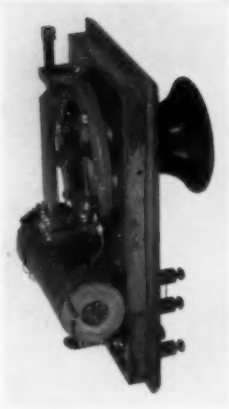
Wall Box Telephone, Rear View, Cover Removed: 1877.

Handset Receiver: 1927.

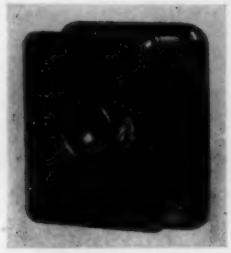
Operator's Receiver: 1884.

Operator's Receiver: 1930.

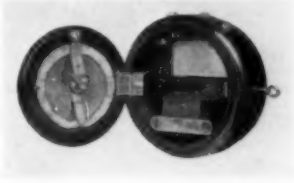
FIGURE 4—*continued*



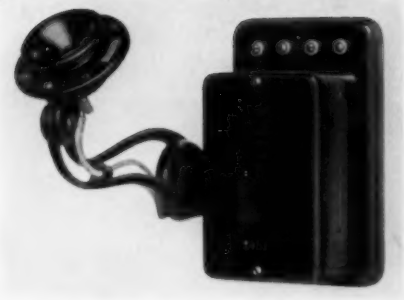
First Blake Transmitter, with Cover Removed: 1878.



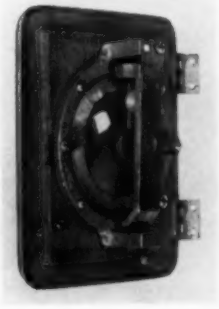
Final Blake Transmitter: 1885.



Berliner Transmitter, in Open Position: 1879.



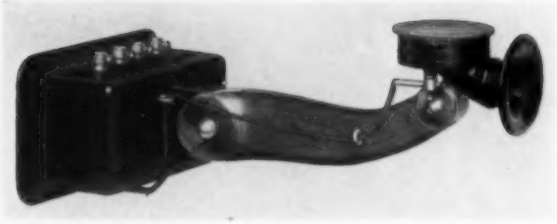
Edison Transmitter: 1881.



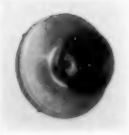
McKinney Transmitter, with Cover Removed: 1883.

Switchboard Transmitter: 1883.

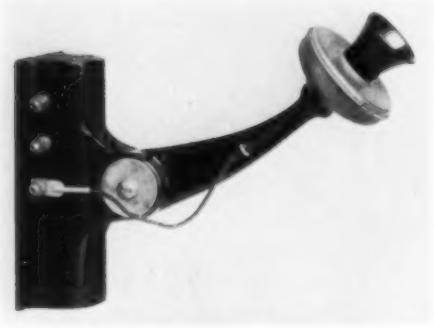
FIGURE 5



Hunnings's, or Long Distance, Transmitter: 1886.



Solid Back Transmitter: 1890.



Bracket Transmitter: 1891.

Handset Transmitter: 1934.

"Gilliland Harness" Operator's Set: 1880.

Operator's Set: 1930.

FIGURE 5—*continued*

mediately above, in which the single permanent magnet with the single coil of wire is replaced by a compound horse shoe magnet with two coils.

"Where are the originals of all these instruments?" is a question often asked. A few are in the Smithsonian Institution at Washington, D. C. Most of the rest suffered the fate of the large majority of subsequent development models—changed almost beyond recognition in the further experimentation to produce better instruments; and some have been lost.

Leaving the embryonic stage of the telephone, we will now pass on to the developments of the telephone from the time of its commercial introduction.

Transmitters and Receivers

Transmitters and receivers, the two most intimate parts of the telephone system from the subscriber's standpoint, follow. From the first designs down to the latest present standard instruments, there are in the collection originals of the first box telephones, large, cumbersome affairs made in the spring of 1877 and promptly modified in design, with some reduction in size. These box telephones were used alternately as transmitters and as receivers, the subscriber having to twist his head for each operation. Then the small "butter stamp" hand telephone, the prototype of the present hand receiver, was developed—also used for talking and listening, changing for each operation by a twist of the wrist instead of the head and sometimes getting the twist reversed to "talk with the ear and listen with the mouth." There were four types of wooden hand telephones, then five types of hard rubber telephones, all developed in 1877. The large box telephones were further modified and reduced to less than half their size by placing the coils and diaphragm parallel to the magnets to mount of a vertical wall to be used as transmitters, while the hand telephones became simply the receivers. These combinations persisted until the latter part of 1878, when the Blake hard carbon button transmit-

ter superseded the wall box type, but the instruments so far considered were all developed during 1877. In early 1878, when switchboards came into commercial use, the various auxiliary devices, such as bells, ringers, party lines and privacy systems thrived, and they made quite presentable outfits at the subscriber stations.

With the opening of the first commercial telephone line on April 4, 1877, from Williams's shop in Boston to his home in Somerville, three miles away, it was not a question simply of talking and listening. How could a person be called to the telephone? Tapping the end of a pencil on the diaphragm produced a comparatively sharp report in the distant telephone, but continued tapping bent the diaphragms out of shape and Watson, Bell's only laboratory assistant, had to go out and renew diaphragms. This took time and energy, and to save himself he designed a hammer to strike forcibly the diaphragm on its edge, where it was secured to the front of the box, by means of a push button. This made a much louder sound and saved the diaphragms. It was known as Watson's " thumper," for at the beginning of the use of the telephone there began the long series of developments of the auxiliary devices that have been carried on to the present day to continually improve the ease and speed with which people may be placed in communication.

From 1878 on, switchboard operators' receivers and transmitters came into the picture, and our exhibits show every type of receiver that has been standardized and used in the Bell System from its inception to the present day. There are 77 different types of standard receivers on exhibit. A group of box telephones and receivers of different periods are shown in Figure 4.

Next follows the transmitter display. Beginning with the Francis Blake, Jr., hard carbon button transmitter, the first Bell commercial variable resistance type appearing in the Fall of 1878, we find several modifications both for subscribers' and

operators' uses until the final one appeared in 1885. Between these dates we find three types of transmitters of Berliner's design and two of Edison's which were used in certain localities for a short period. There is also a McKinney transmitter, a modification of the Blake transmitter, for use by switchboard operators. In the final Blake transmitter are also found the contributions of Berliner and Edison.

During 1886, the first granular carbon transmitter appeared. It was called the Hunnings' or long distance transmitter. In 1878 Hunnings, an Englishman, patented a transmitter using a chamber partly filled with pulverized engine coke, a light, porous form of carbon. The American rights to this invention were later purchased by the Bell Company and the commercial instrument, after considerable laboratory development, appeared with granules of hard anthracite coal, which was found by Edison to be superior to pulverized engine coke. Next, we find a granular carbon button replacing the hard carbon button of the Blake structure, and in 1890 the so-called "solid back" transmitter designed by Anthony C. White, in which the carbon button had its rear electrode secured to a metal bridge at the back and the front electrode to the diaphragm. This rugged structure superseded all previous types and was in use in all Bell transmitters for regular telephone service until the advent of the present-day handset transmitter, first brought out in 1927. From 1891 through to 1935, the date of the latest standard instrument, we find numerous types of transmitters, varying from one another in design. Among them may be found the high and low resistance buttons for common battery and local battery service, transmitters on large cast brackets and later on formed steel brackets, side damped and centrally damped diaphragms, a series of Blake transmitter boxes with solid back units replacing the hard carbon buttons, and other changes, the group showing continued improvement from all standpoints—efficiency, design and manufacture. There are 118 different types of standard transmitters on exhibit. A

group of transmitters of varying designs, and two operators' sets, are shown in Figure 5.

On the wall opposite the transmitters, we find an enlarged, mechanically operated, cross-section model of a transmitter and hand receiver, with dry batteries and an induction coil symbolizing the exchange apparatus between the two stations (Figure 6). This has proved an extremely interesting and instructive exhibit in that it illustrates in an easily understood manner the relation between the vibration of the transmitter diaphragm caused by the speaker's voice, the transformation of the sound waves into a varying electric current, and the reverse action at the receiver where the varying current causes the receiver diaphragm to vibrate in the same manner as the transmitter diaphragm to produce sound waves in the listener's ear. No matter what the distance between the transmitter and receiver, be it 10 feet or 10,000 miles, or even around the globe, the vibrations of these two diaphragms must correspond in order to transmit properly a telephone message.

Desk Stands and Hand Telephone Sets

Next we see the evolution of the telephone desk stand, from the Blake transmitter on an upright pedestal in 1879 through the years to 1922, when the dial appeared on the base. Adjacent to these are the handsets, the earliest one dated 1879 and the latest 1930. Some of these are shown in Figure 7.

It is interesting to note that the handset of 1879 was invented by an American, Mr. Robert G. Brown, then an engineer for the Gold and Stock Telephone Company in the Telephone Exchange in New York City. During this year, Mr. Brown went to France to install a telephone system in Paris and he took with him the handset idea. In America, this early type was used only by the switchmen in the central offices. It was equipped with an Edison type transmitter which was later superseded by the Blake type which operated best in a vertical position.

Subscriber Sets

Our last group of apparatus intimately associated with the public is the subscriber or telephone sets that began with the introduction of switchboards early in 1878. There is one whole case full of these instruments as well as a few mounted on one of the pylons and on the exhibit board nearby. The earliest set is that used with the New Haven switchboard of January, 1878. The exhibits include practically every kind of set made under license of the Bell Company by different manufacturers until the Western Electric Company became the manufacturer for the Bell Company in 1882. Among them are sets and miscellaneous secrecy switches made or designed by Williams, Davis and Watts, Post, Gilliland, Standard Electrical Works, Wotton and Gentry, Chinnock, Prescott, Anders, Phelps, Doolittle, Cheever, Currier, Carey, and Vail. In the early days, the instrument was usually known by the name of the person who contributed some specific feature to its design and many were the ideas that were put into use throughout the system during these times. The latest types of magneto and common battery subscriber sets are also on display. Two subscriber sets are shown in Figure 7.

Telephone and Telegraph Cable

The first telephone lines were made of iron wire, a single conductor with a ground return. A sample of the iron wire installed in 1879 between Au Sable and Black Rock, New York State, only recently came into our possession. As early as December, 1877, hard drawn copper wire, developed by Thomas B. Doolittle, was used on a few telephone lines. Eventually it almost entirely superseded iron wire for use in toll circuits. We have samples of the first lot of hard drawn copper wire made by Doolittle, and of the copper wire of the long distance line between Boston and New York which was opened in 1884. With the ever-increasing use of the tele-

phone, the open wires became too numerous for comfort and steps were taken to develop cable, both aerial and underground. Our exhibits of cable development, both telephone and telegraph, are shown in Figure 8.

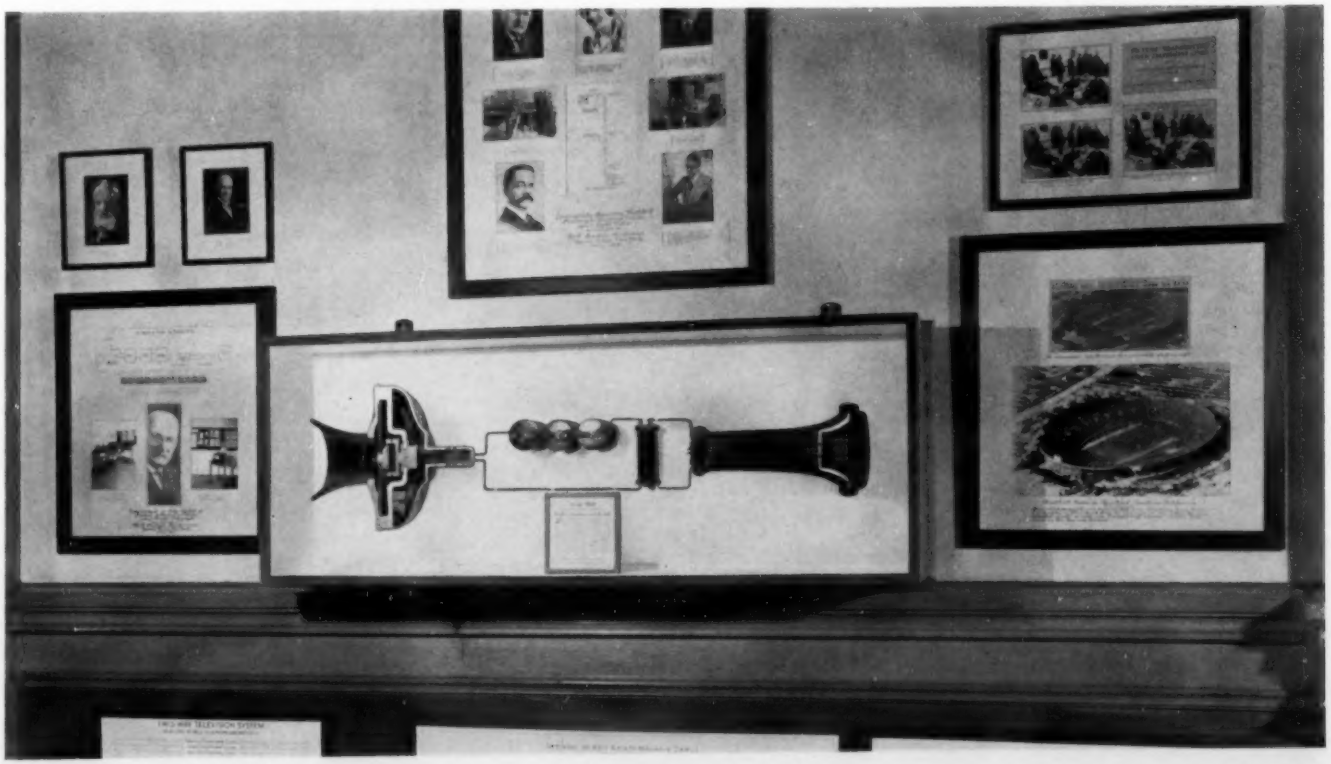
On the upper right of the top shelf are seen sections of the Havana-Key West submarine telephone and telegraph cables, three laid in 1921 and a fourth in 1931, the last having the same message capacity as the first three combined, due to improvements in the design and materials. The later cable includes for the first time paragutta, developed in these Laboratories to replace gutta percha for insulation of the conductor. There are also pieces of the Catalina Island-Long Beach, Cal., submarine cable laid in 1923, which replaced the radio link between these two places. On the left are shown deep sea sections of five transoceanic telegraph cables laid in the Atlantic and Pacific oceans and having permalloy tape continuous loading. These were laid in 1924–1926. The introduction of permalloy continuous loading was an outstanding development and it increased the speed capacity from four to five times over that of earlier cables. On the second shelf, beginning at the right, are samples of Cyrus W. Field's first, second and third Atlantic telegraph cables of 1858, 1865 and 1866, respectively; other miscellaneous telegraph cables; samples of the high frequency stranded conductors of 1915, developed in these Laboratories; and, at the left, samples of the coaxial cable, the late development of a high frequency conductor capable of carrying over one million cycles for an ultimate capacity of 240 or more simultaneous telephone conversations. On the third shelf, we have a rather complete collection of exchange area telephone cables. Beginning at the right are a few miscellaneous early types, including the glass insulated telegraph cable manufactured by the Western Electric Company in 1880 for the Western Union Telegraph Company and laid in Chicago. The first tall exhibit is the 60-pair cotton insulated cable of 1888 pulled through a lead pipe prior to the introduction of the extruded

lead sheath about 1892. Following along to the left, we see the gradual growth in capacity of these cables up to the 1818-pair first used in 1927. To the left of the case, mounted on the sill of the window at the rear, are two exhibits of cotton insulated, rosin oil filled cable, one with lead foil covering instead of the usual sheath and one with an iron pipe covering the splice between two cables. These cables were laid in Philadelphia in 1888 and 1889. On the bottom shelf of the case, beginning at the right, we have the exhibits portraying the development of toll cables beginning with the 30-pair, No. 16 gauge Boston-Lynn cable of 1889 down to the 282 circuit No. 16 and No. 19 gauge New York-Chicago cable of 1925. Prior to the advent of the vacuum tube telephone repeaters in 1915, the longer toll cables required heavier gauge wire, so we find in the Boston-Washington underground cable conductors No. 16, No. 13 and even No. 10 gauge copper wire. The development of steel tape armored lead covered cable for laying underground without conduit is illustrated in a section of the Fort Worth-Cisco, Texas, cable laid in 1929.

Toward the center of the bottom shelf is a small group of cables of foreign manufacture, and at the left are exhibits of paper insulated lead covered short submarine cables; the one on the extreme left being that laid under the Golden Gate in San Francisco in 1930. This cable is probably the largest submarine telephone cable ever constructed. It is 4½ inches in outside diameter and contains 150 quads of No. 19 gauge and 8 quads of No. 16 gauge conductors. The pylon at the extreme right of the photograph, somewhat out of focus, has numerous photographs showing the line construction on the roofs of exchanges and the heavy open wire lines on poles prior to the introduction of telephone cables. There are also several samples of early insulators.

Line Apparatus

We next see developments pertaining to the line. "Mechanical" repeaters of the Shreeve type were in use between 1904 and 1914 for long telephone lines extending from the Atlantic coast as far west as Denver, Colorado, after which the vacuum tube type was used on the New York-San Francisco Transcontinental Line opened in 1915. There are also shown the Campbell (model) and Pupin (original) experimental air core loading coils prior to the commercial introduction of these coils in 1901, with insulated iron wire cores for economy in space and cost of manufacture; and the subsequent developments of air-gap coils in 1913, compressed iron dust core coils in 1916, and permalloy dust core coils in 1927. Nearby is an operating exhibit to enable the visitor, by reading deflections on a galvanometer, to observe the relative permeabilities of brass (non-magnetic), iron (magnetic), and permalloy (supermagnetic). The development of permalloy, an alloy of nickel and iron with a much higher initial permeability than iron, and the technique of manufacturing it in pulverized form for loading coils, has effected a noteworthy economy in manufacture as well as in reduction in the size of the unit coil over the iron dust core coil. Continued research in magnetic materials has recently brought forth an alloy of such electrical characteristics that the size of the completed coil will be still further reduced, by approximately one-third, but this new coil has not yet been placed in the field, so is not ready to exhibit in the museum. In this case, we also find examples of the old wet batteries used for the local subscriber stations in the early days. There is a collection of early insulators, lightning arresters, and fuses; the latest sub-station spark gap and fuse protector; and a few early cable terminals, among which is the "Grace" cable terminal of 1903, which in 1904 became known as the No. 14 cable terminal. Some of this line material is illustrated in Figure 9.



An Operating Model of Transmitter and Receiver; and, Around It, Pictures of Telephotograph Developments, 1923–35.

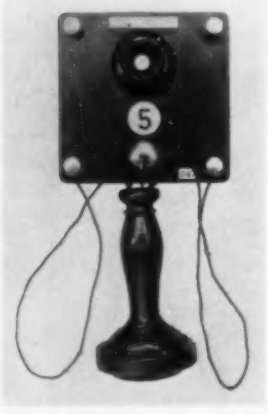
FIGURE 6

Blake Telephone Stand: 1879.

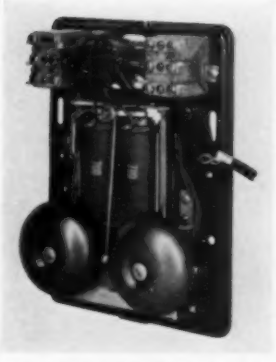
Desk Telephone, with Dial: 1922.

Telephone Handset: 1879.

Telephone Handset: 1930.



Subscriber Set, New Haven: 1878.



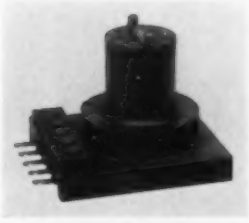
Bell Box for 1930 Handset, with Cover Removed.

FIGURE 7

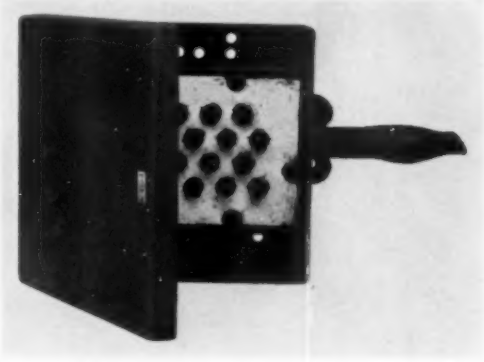
Exhibits of Telephone and Telegraph Cable Development.

FIGURE 8

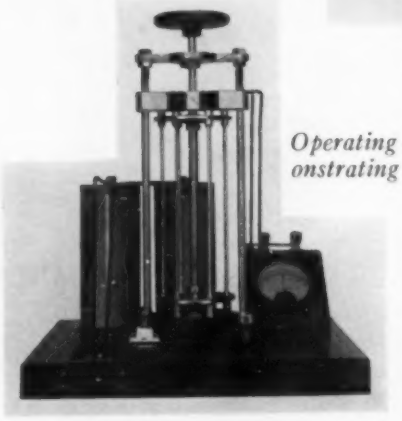
Loading Coils: Campbell, Pupin, 1900; Iron Wire Core, 1901; Iron Dust Core, 1916; Permalloy Dust Core, 1927.



Shreeve Repeater: 1912.

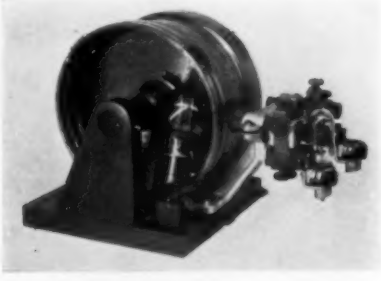


Grace Cable Terminal: 1903.



Operating Exhibit Demonstrating Permeability.

FIGURE 9



Unit of Call Announcer Apparatus: 1929.

FIGURE 10

Central Office Apparatus

The development of central office apparatus occupies the greater part of two single cases. In these are shown exhibits of the earliest and latest plugs, jacks, keys, signals, relays, lamps, lamp caps, cord weights, resistances, message registers, and switchboard clocks. The plugs and jacks begin with code number 1 in each case and continue by type to the latest standard designs. Prior to the present use of code numbers, parts of central office apparatus, like subscriber sets, were known by the name of the designer or the locality where first used. For examples, we have the Williams', Gilliland, Chicago, Detroit, Philadelphia, Liverpool, Antwerp plugs and Scribner, Thayer, Philadelphia, Central Avenue Union, Detroit jacks, a McDaniel's switch and others. Most of these however, were later assigned code numbers. Signals and relays begin with exhibits prior to the time code numbers were assigned. Two developments of train dispatching selectors are also shown.

An interesting exhibit in this case is a unit of the call announcer of 1929, shown in Figure 10. This equipment in a metropolitan office converts the dial impulses into spoken numbers, with or without a party line letter, of a called subscriber in a suburban district. These spoken numbers are heard by the operator in the outlying manual central office. There may be seen the exciting lamp, lens, sound film, on each edge of the continuously revolving drum, and the photoelectric cell. This is a standard arrangement for sound on film reproduction. Each edge of the several revolving drums in the complete central office equipment contains four sections of sound film of a digit or letter. The various dialed numbers or letters through circuit combinations control the proper sequence of the current from the photoelectric cell (amplified) to pass out on the line to the distant operator.

W. C. F. Farnell

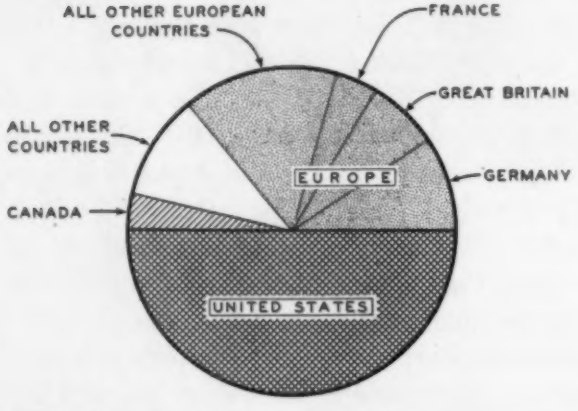
(*To be concluded*)

The World's Telephone Statistics

January 1, 1935

THERE were 33,539,890 telephones in the world on January 1, 1935, or approximately the same number as were in service just prior to the world-wide business depression which began in 1929. The latest survey of the world's telephone facilities, undertaken by the Chief Statistician of the

DISTRIBUTION OF THE WORLD'S TELEPHONES
January 1, 1935

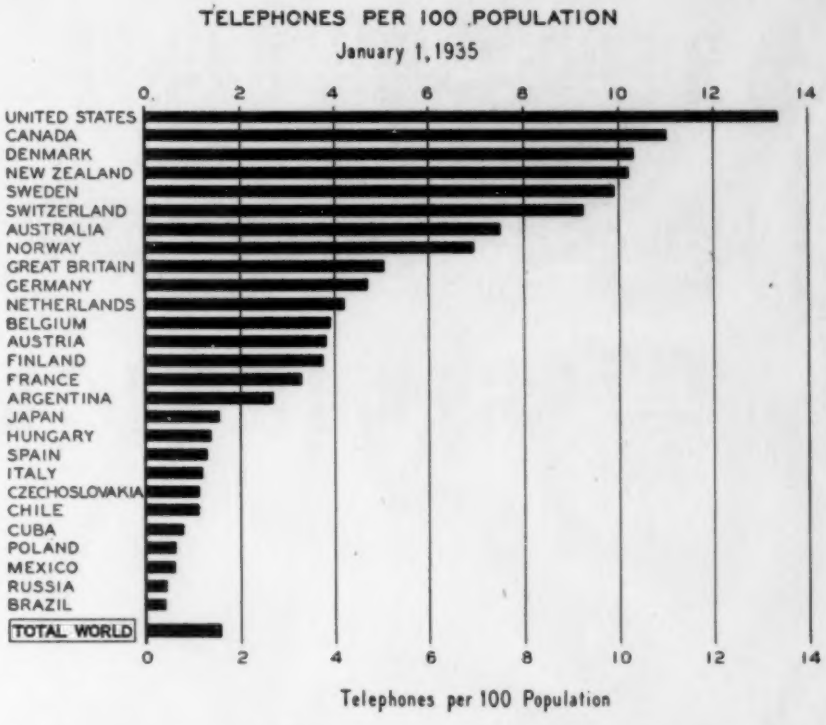


American Telephone and Telegraph Company, was published recently as a pamphlet entitled "Telephone and Telegraph Statistics of the World, January 1, 1935," from which the tables and charts referred to in the following paragraphs have been taken.

Comparative Telephone Development by Countries

On January 1, 1935, there were 16,868,955 telephones in the United States, representing slightly more than one-half of

the total number of instruments in the world on that date. A more significant measure of the comparative extent of telephone facilities, however, is furnished by the number of telephones in relation to the population served, as shown in the table "Telephone Development of the World, by Countries" and its accompanying chart "Telephones per 100 Population." As in previous years, the United States exceeds all other coun-



tries in terms of this measure of telephone development, having 13.36 telephones for each 100 of its population, or over six times the corresponding telephone development of Europe. Canada continues in second position, with 11.00, followed by Denmark with 10.31 and New Zealand with 10.20 telephones per 100 population. In fact, these four countries are the only ones having more than one telephone for every ten inhabitants.

TELEPHONE DEVELOPMENT OF THE WORLD, BY COUNTRIES

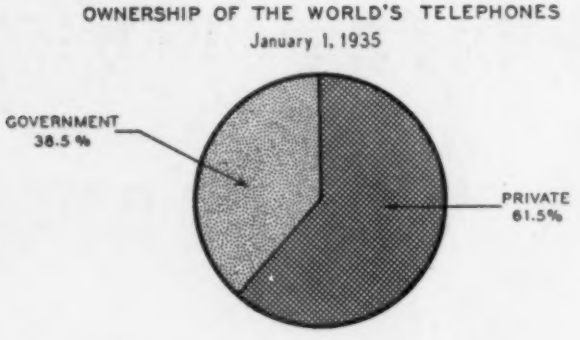
January 1, 1935

Countries	Number of Telephones			Percent of Total World	Telephones Per 100 Population
	Government Systems	Private Companies	Total		
NORTH AMERICA:					
United States	—	16,868,955	16,868,955	50.29%	13.36
Canada	190,602	1,003,127	1,193,729	3.56%	11.00
Central America	11,748	13,921	25,669	.08%	0.37
Mexico	1,337	107,315	108,652	.32%	0.62
West Indies:					
Cuba	500	32,494	32,994	.10%	0.79
Puerto Rico	537	11,529	12,066	.04%	0.72
Other W. I. Places	7,594	14,800	22,394	.07%	0.33
Other No. Am. Places	—	11,111	11,111	.03%	3.03
Total	212,318	18,063,252	18,275,570	54.49%	10.47
EUROPE:					
Austria	258,748	—	258,748	.77%	3.82
Belgium**	323,423	—	323,423	.96%	3.91
Bulgaria	20,646	—	20,646	.06%	0.34
Czechoslovakia	150,245	21,401	171,646	.51%	1.13
Denmark#	16,401	361,164	377,565	1.13%	10.31
Finland	2,369	138,698	141,067	.42%	3.75
France	1,399,869	—	1,399,869	4.17%	3.30
Germany#	3,134,103	—	3,134,103	9.34%	4.69
Great Britain and No. Ireland	2,366,311	—	2,366,311	7.06%	5.06
Greece	—	26,712	26,712	.08%	0.40
Hungary	121,067	735	121,802	.36%	1.37
Irish Free State#	34,799	—	34,799	.11%	1.16
Italy	—	516,075	516,075	1.54%	1.19
Jugo-Slavia	47,234	2,612	49,846	.15%	0.34
Latvia#	65,345	—	65,345	.20%	3.35
Netherlands	352,741	—	352,741	1.05%	4.20
Norway*	121,231	78,453	199,684	.60%	6.96
Poland	118,904	92,430	211,334	.63%	0.63
Portugal	10,833	38,633	49,466	.15%	0.70
Roumania	—	56,797	56,797	.17%	0.30
Russia¶	739,381	—	739,381	2.20%	0.43
Spain	—	312,719	312,719	.93%	1.28
Sweden	615,554	1,393	616,947	1.84%	9.90
Switzerland	383,289	—	383,289	1.14%	9.25
Other Places in Europe	85,153	13,290	98,443	.29%	1.29
Total	10,367,646	1,661,112	12,028,758	35.86%	2.13

SOUTH AMERICA:					
Argentina	—	322,873	322,873	.96%	2.69
Bolivia	—	2,218	2,218	.01%	0.07
Brazil	1,924	190,742	192,666	.57%	0.41
Chile	—	50,360	50,360	.15%	1.12
Colombia	7,407	25,377	32,784	.10%	0.34
Ecuador	3,121	3,250	6,371	.02%	0.25
Paraguay	—	2,996	2,996	.01%	0.33
Peru	—	20,985	20,985	.06%	0.32
Uruguay	19,651	12,532	32,183	.09%	1.60
Venezuela	600	18,685	19,285	.06%	0.58
Other So. Am. Places	2,803	—	2,803	.01%	0.52
Total	35,506	650,018	685,524	2.04%	0.75
ASIA:					
British India#	24,328	40,120	64,448	.19%	0.02
China	70,000	94,000	164,000	.49%	0.04
Japan#	1,068,244	—	1,068,244	3.19%	1.56
Other Places in Asia	141,106	66,593	207,699	.62%	0.13
Total	1,303,678	200,713	1,504,391	4.49%	0.14
AFRICA:					
Egypt	49,765	—	49,765	.15%	0.23
Union of South Africa#	140,349	—	140,349	.42%	1.64
Other Places in Africa	97,750	1,970	99,720	.30%	0.09
Total	287,864	1,970	289,834	.87%	0.20
OCEANIA:					
Australia*	501,402	—	501,402	1.49%	7.51
Dutch East Indies	37,407	3,641	41,048	.12%	0.06
Hawaii	—	23,857	23,857	.07%	6.36
New Zealand#	159,170	—	159,170	.48%	10.20
Philippine Islands	6,000	20,358	26,358	.08%	0.19
Other Places in Oceania	3,700	278	3,978	.01%	0.17
Total	707,679	48,134	755,813	2.25%	0.83
TOTAL WORLD	12,914,691	20,625,199	33,539,890§	100.00%	1.58

* June 30, 1934.
** February 28, 1935.
# March 31, 1935.
¶ U.S.S.R., including Siberia and Associated Republics.
§ Includes approximately 15,560,000 automatic or "Dial" telephones, of which about 45% are in the United States.

The major European countries rank lower in relative telephone development; thus, Great Britain with 5.06 telephones per 100 population ranks tenth among the countries of the world. Germany, with a total of 3,134,103 telephones, has more telephones than any other country except the United States, but ranks only eleventh in relative telephone development with 4.69 telephones per 100 population, while France, with 3.30, ranks seventeenth. Japan has 1,068,244 telephones and ranks twenty-first in telephone development (1.56). In South America, Argentina leads in telephone development, with 322,873 telephones, but still has only 2.69 telephones for every 100 of its people.



More than 61 per cent of the world's telephones are operated by privately owned systems and private ownership tends to predominate in the countries with the highest telephone development. In the United States, the best developed country in the world in point of telephone facilities by a substantial margin, the service is wholly privately operated. Canada, with 84 per cent of the telephones under private operation, is second in telephone development. In Denmark, the world's third highest ranking country in respect of telephone development, 96 per cent of the telephones are owned and operated by private companies. On the other hand, Great Britain, Germany, and France, where all telephone service is operated by

TELEPHONE DEVELOPMENT OF LARGE AND SMALL COMMUNITIES

January 1, 1935

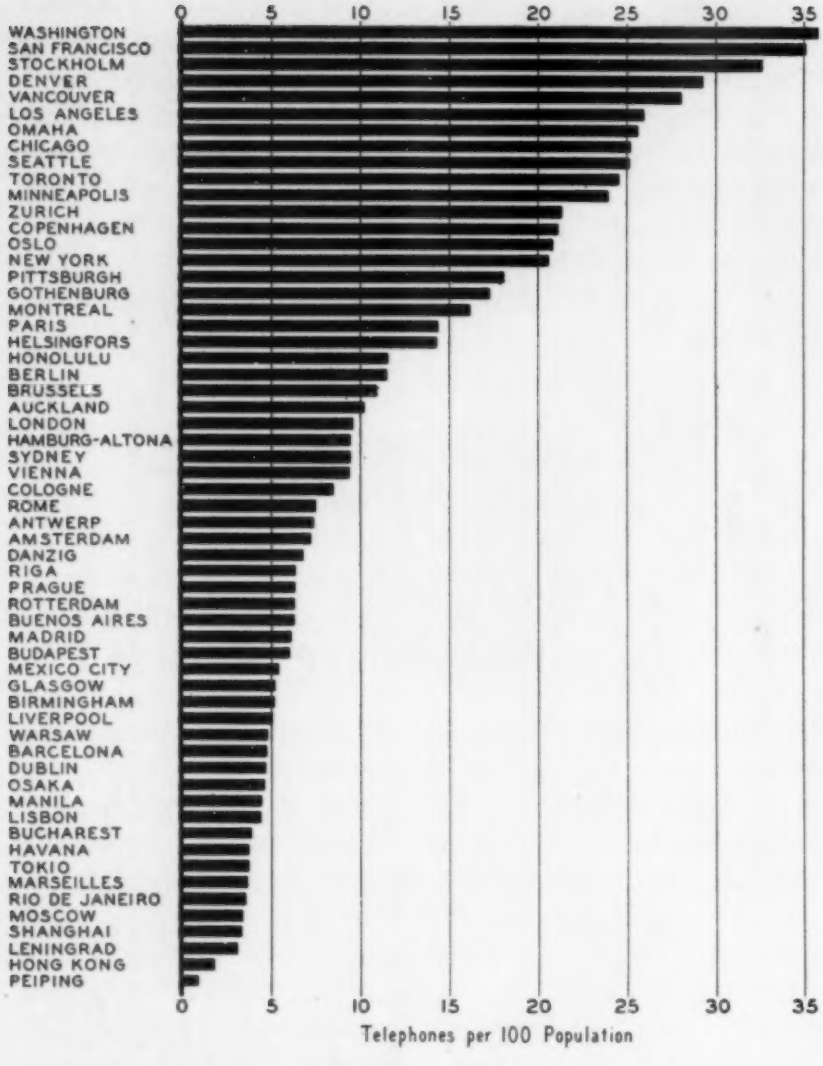
Country	Service Operated by (See Note)	Number of Telephones		Telephones per 100 Population	
		In Communities of 50,000 Population and Over	In Communities of less than 50,000 Population	In Communities of 50,000 Population and Over	In Communities of less than 50,000 Population
Australia*	G.	293,477	207,925	9.07	6.04
Austria	G.	197,134	61,614	8.97	1.35
Belgium**	G.	227,133	96,290	6.43	2.03
Canada	P. G.	647,481	546,248	18.99	7.34
Czechoslovakia	P. G.	87,092	84,553	5.06	0.63
Denmark	P.	196,404	183,596	19.07	6.95
Finland	P.	54,141	86,926	11.00	2.66
France	G.	755,526	644,343	8.51	1.92
Germany†	G.	1,897,458	1,056,156	7.12	2.69
Great Britain and No. Ireland#	G.	1,740,600	676,000	6.59	3.33
Hungary	G.	92,679	29,123	4.53	0.43
Japan#	G.	699,811	368,433	3.51	0.76
Netherlands	G.	229,881	122,860	6.71	2.47
New Zealand#	G.	63,730	95,440	11.10	9.68
Norway*	P. G.	78,421	121,263	19.36	4.92
Poland	P. G.	122,452	88,882	2.46	0.31
Spain	P.	193,841	118,878	3.80	0.61
Sweden	G.	240,801	376,146	23.13	7.24
Switzerland	G.	173,861	209,428	19.76	6.41
Union of South Africa	G.	82,487	57,852	7.25	0.78
United States	P.	9,608,965	7,259,990	18.91	9.62

Note: P. indicates that the telephone service is wholly or predominantly operated by private companies, G. wholly or predominantly by the Government, and P. G. by both private companies and the Government. See first table.

* June 30, 1934.
† March 31, 1934.
** February 28, 1935.
# March 31, 1935.

TELEPHONES PER 100 POPULATION
OF LARGE CITIES

January 1, 1935



government agencies, have a telephone development only a fourth to a third as high as that in the United States.

Telephones in Large Cities

At the beginning of 1935, the largest 54 cities in the United States had more telephones (7,570,610) than France, Germany, and Great Britain combined, despite the fact that the aggregate population of these three countries is many times that of the 54 American cities. Among the large cities of the world, Washington, D. C., leads in relative telephone development, with 35.80 telephones per 100 population, closely followed by San Francisco, with 35.08. Stockholm, Sweden, ranked third with 32.64 and far exceeded all other European cities. As a matter of fact, the next highest ranking city in Europe was Berne, Switzerland, with 21.92 telephones per 100 population—a development exceeded by as many as 33 cities in the United States. London, a larger city than New York, had 891,725 telephones compared with New York's 1,493,374 telephones, and a relative development of 9.59 compared with New York's 20.61 telephones per 100 population. Berlin, somewhat larger than Chicago, had 488,244 telephones and a relative development of 11.49, while Chicago had 824,293 telephones or 25.21 per 100 population. Paris had 416,870 telephones and a development of 14.35, or about one-half the development of Los Angeles (25.95), which had 341,221 telephones.

Telephones in Large and Small Communities

The general penetration of telephone service in communities of all sizes in the United States may be seen from the following tabulation:

	Telephones per 100 Population
Communities with over 1,000,000 population	20.38
Communities with 500,000 to 1,000,000 population	20.27
Communities with 200,000 to 500,000 population	17.78
Communities with 50,000 to 200,000 population	16.54
Communities with less than 50,000 population	9.62

TELEPHONE DEVELOPMENT OF LARGE CITIES
January 1, 1935

Country and City (or Exchange Area)	Estimated Population (City or Exchange Area)	Number of Telephones	Telephones per 100 Population
ARGENTINA:			
Buenos Aires	3,000,000	188,528	6.28
AUSTRALIA:			
Adelaide	314,000	28,949	9.22
Brisbane	305,000	26,707	8.76
Melbourne	1,000,000	103,137	10.31
Sydney	1,249,000	117,759	9.43
AUSTRIA:			
Graz	153,000	10,784	7.05
Vienna	1,875,000	175,947	9.38
BELGIUM: **			
Antwerp	530,000	39,228	7.40
Brussels	965,000	105,654	10.95
Liege	424,000	23,695	5.59
BRAZIL:			
Rio de Janeiro	1,800,000	64,046	3.56
CANADA:			
Montreal	1,016,700	164,594	16.19
Ottawa	188,000	35,441	18.85
Toronto	766,300	188,287	24.57
Vancouver	187,500	52,549	28.03
CHINA:			
Canton	1,060,000	8,056	0.76
Hong Kong	850,000	14,845	1.75
Peiping	1,540,000	12,948	0.84
Shanghai ††	1,650,000	54,861	3.32
CUBA:			
Havana	700,000	25,899	3.70
CZECHOSLOVAKIA:			
Prague	913,000	57,725	6.32
DANZIG:			
Free City of Danzig	265,000	17,964	6.78
DENMARK:			
Copenhagen	820,000	173,372	21.14
FINLAND:			
Helsingfors	270,000	38,653	14.32
FRANCE:			
Bordeaux	268,000	20,348	7.59
Lille	202,000	17,346	8.59
Lyons	670,000	35,317	5.27
Marseilles	930,000	34,165	3.67
Paris	2,905,000	416,870	14.35
GERMANY:#			
Berlin	4,250,000	488,244	11.49
Breslau	630,000	42,185	6.70
Cologne	765,000	64,935	8.49
Dresden	735,000	60,899	8.29
Dortmund	585,000	23,958	4.10
Essen	665,000	30,254	4.55
Frankfort-on-Main	655,000	61,968	9.46
Hamburg-Altona	1,650,000	155,826	9.44
Leipzig	775,000	65,038	8.39
Munich	745,000	79,219	10.63
GREAT BRITAIN AND NO. IRELAND:#			
Belfast	415,000	19,280	4.65
Birmingham	1,210,000	62,147	5.14
Bristol	417,000	22,711	5.45
Edinburgh	444,000	34,565	7.78
Glasgow	1,195,000	61,747	5.17
Leeds	514,000	25,922	5.04
Liverpool	1,200,000	60,131	5.01
London	9,300,000	891,725	9.59
Manchester	1,103,000	67,336	6.10
Newcastle	471,000	20,558	4.36
Sheffield	520,000	21,202	4.08
HAWAII:			
Honolulu	138,000	15,942	11.55
HUNGARY:			
Budapest	1,360,000	81,886	6.02
Szeged	138,000	2,100	1.52
IRISH FREE STATE:#			
Dublin	429,000	19,920	4.64

TELEPHONE DEVELOPMENT OF LARGE CITIES (Concluded)

January 1, 1935

Country and City (or Exchange Area)	Estimated Population (City or Exchange Area)	Number of Telephones	Telephones per 100 Population
ITALY:			
Milan	1,065,000	88,701	8.33
Naples	880,000	27,098	3.08
Rome	1,150,000	86,393	7.51
JAPAN:#			
Kobe	854,000	34,700	4.06
Kyoto	1,053,000	42,408	4.03
Nagoya	1,018,000	34,846	3.42
Osaka	2,723,000	124,883	4.59
Tokio	5,663,000	209,605	3.70
LATVIA:#			
Riga	385,000	24,437	6.35
MEXICO:			
Mexico City	1,150,000	61,969	5.39
NETHERLANDS:			
Amsterdam	782,000	56,468	7.22
Haarlem	162,000	12,775	7.89
Rotterdam	616,000	38,808	6.30
The Hague	518,000	48,939	9.45
NEW ZEALAND:#			
Auckland	218,000	22,236	10.20
NORWAY:*			
Oslo	250,000	52,198	20.88
PHILIPPINE ISLANDS:			
Manila	394,000	17,328	4.40
POLAND:			
Lodz	900,000	14,356	1.60
Warsaw	1,260,000	59,842	4.75
PORTUGAL:			
Lisbon	651,000	28,470	4.37
ROUMANIA:			
Bucharest	640,000	24,718	3.86
RUSSIA:			
Leningrad	3,000,000	91,023	3.03
Moscow	4,000,000	134,440	3.36
SPAIN:			
Barcelona	1,080,000	51,014	4.72
Madrid	1,000,000	61,017	6.10
SWEDEN:			
Gothenburg	255,000	44,228	17.32
Malmö	139,000	21,591	15.56
Stockholm	441,000	144,011	32.64
SWITZERLAND:			
Basel	151,000	32,441	21.48
Berne	114,000	24,992	21.92
Geneva	147,000	27,235	18.53
Zurich	268,000	57,330	21.39
UNITED STATES: (See Note)			
New York	7,247,000	1,493,374	20.61
Chicago	3,270,000	824,293	25.21
Los Angeles	1,315,000	341,221	25.95
Pittsburgh	1,015,900	183,761	18.09
Total 10 cities over 1,000,000 Population	21,777,600	4,437,758	20.38
Milwaukee	763,200	135,963	17.81
San Francisco	690,000	242,026	35.08
Washington	528,000	189,017	35.80
Minneapolis	505,000	121,123	23.98
Total 10 cities with 500,000 to 1,000,000 Population	6,515,300	1,320,692	20.27
Seattle	417,200	105,087	25.19
Denver	300,000	87,755	29.25
Omaha	238,600	61,186	25.64
Hartford	237,300	53,224	22.43
Total 34 cities with 200,000 to 500,000 Population	10,191,900	1,812,160	17.78
Total 54 cities with more than 200,000 Population	38,484,800	7,570,610	19.67

NOTE: There are shown, for purposes of comparison with cities in other countries, the total development of all cities in the United States in certain population groups, and the development of certain representative cities within each of such groups.

* June 30, 1934. ** February 28, 1935. # March 31, 1935.

†† International Settlement and French Concession.

The last figure is particularly significant in view of the fact that it represents a telephone development for the more sparsely settled areas of the United States which not alone surpasses the total telephone development of all but a few other countries, but even exceeds the urban telephone development of all but seven foreign countries. This situation is a reflection of the fact that in foreign countries telephone facilities tend to be concentrated in the larger metropolitan centers, with much more limited service being provided in the smaller communities and rural areas. Thus, the city of London had over 36 per cent of all the telephones in Great Britain and Northern Ireland, while communities of less than 50,000 inhabitants in Great Britain had only 3.33 telephones per 100 population, or approximately one-third of the corresponding development in the United States. Similarly, almost 30 per cent of all French telephones were in Paris, the development of communities of less than 50,000 inhabitants in France being only one-fifth as high as that of corresponding communities in the United States. New York and Chicago combined, on the other hand, had less than 14 per cent of all telephones in the United States.

K. FICK

Notes On Recent Occurrences

FURTHER REDUCTIONS IN RATES FOR OVERSEAS TELEPHONE SERVICE

ON July 1 reduced rates became effective for telephone calls from all places in the United States to most foreign countries. Reductions apply to nearly 50 of the 68 countries which may be reached from Bell System telephones. Negotiations are under way looking to reductions on charges for overseas calls to other countries. The reductions apply to day rates and to night rates, and introduce a reduced rate on Sunday. Reductions were also made in rates from the United States to Cuba, which is reached by deep sea cable.

Under the new schedule, three-minute calls from the eastern seaboard cities to Paris and London are reduced from $30 to $21 in the day time, and the Sunday and night charge is $15. This is a reduction, on three-minute calls to countries in Europe, of $9 on week days, $6 at night, and $15 on Sundays. Three-minute calls from Pacific Coast cities to the Territory of Hawaii are reduced from $21 to $15 on week days, while the new Sunday rate is $10.50. Similar calls to the Philippines are reduced from $30 to $21 on week days, with a Sunday rate of $15. Three-minute calls to the countries of Argentina, Brazil, Chile, Paraguay, Peru and Uruguay in South America are reduced $9 on week days and $15 on Sundays, while calls to Colombia are reduced $9 on week days and $13.50 on Sundays. Similar calls to the Central American Republics of Costa Rica, Guatemala, Honduras, Nicaragua, and Panama are reduced $9 on week days and $12 on Sundays. Calls to Puerto Rico and the Dominican Republic are reduced $6 on week days and $9 on Sundays. Rates for conversations extending beyond three minutes are similarly reduced. To Cuba,

three-minute station-to-station calls are reduced by $1.50 and person-to-person calls correspondingly; also, the schedule introduces reduced night and Sunday rates.

Since the American Telephone and Telegraph Company inaugurated radio-telephone service to Europe in 1927, there have been two previous substantial reductions in charges for the service. When the service opened, a three-minute conversation between New York and London cost $75. In 1928 the rate was reduced to $45, and in 1930 the Company made a further reduction to $30. The present reduction brings it to $21.

The following table compares the former and the new day rates for a three-minute conversation:

	Former Rate	New Week-day	New Sunday
New York–London	$30	$21	$15
New York–Buenos Aires	30	21	15
New York–Rio de Janeiro	30	21	15
New York–Lima	30	21	15
New York–Paris	30	21	15
New York–Berlin	33	24	18
New York–Santiago, Chile	33	24	18
New York–Panama City	21	12	9
New York–Guatemala	21	12	9
New York–San Juan	18	12	9
Seattle–Honolulu	21	15	10.50
Los Angeles–Manila	30	21	15.00
Miami–Bogota	21	12	7.50
New York–Ciudad Trujillo	18	12	9

The night rates to London, Paris and Berlin are the same as the Sunday rates under the new schedule.

BELL SYSTEM OPENS SERVICE TO EL SALVADOR

TELEPHONE service with El Salvador, Central America, was opened on June 10 with an exchange of greetings between Secretary of State Cordell Hull at Washington and Dr. Miguel A. Araujo, Minister of Foreign Relations for El

Salvador at San Salvador. Others taking part in the inaugural conversations included Don Hector D. Castro, Salvadoran Minister to the United States, at Washington, and Frank P. Corrigan, American Minister to El Salvador.

With the extension to El Salvador, service from Bell and Bell-connecting telephones is now available to all of the Central American Republics. El Salvador is the most densely populated country in the western hemisphere, with a population estimated at 1,670,000 in an area of 13,000 square miles.

The cost of a three-minute conversation between New York and San Salvador is $12.00, with $4.00 for each additional minute. Connection is established over a short wave radio telephone circuit between A. T. & T. Company stations at Miami, Fla., and a Salvadoran radio-telephone station located at San Salvador.

BELL SYSTEM OFFICIALS RECEIVE HONORARY DEGREES

WORCESTER Polytechnic Institute conferred the honorary degree of Doctor of Engineering on Bancroft Gherardi, Vice President and Chief Engineer of the American Telephone and Telegraph Company, at its Commencement exercises on June 12. Dr. Gherardi delivered the Commencement Address to the graduating class.

At its Commencement exercises on June 18 Harvard University conferred the honorary degree of Doctor of Science on Frank B. Jewett, Vice President of the American Telephone and Telegraph Company and President of the Bell Telephone Laboratories.

Other members of the Laboratories who received honorary doctorates were: O. E. Buckley, Doctor of Science, from Grinnell College; J. R. Carson, Doctor of Science, from Brooklyn Polytechnic Institute; and M. J. Kelly, Doctor of Engineering, from the School of Mines and Metallurgy of the University of Missouri.